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PUBLIC WORKS

An Engineering and Construction Monthly

310 EAST 45TH ST. NEW YORK, N. Y.
CITY COUNTY STATE

PUBLIC WORKS is devoted to the design, construction, maintenance and operation of *public improvements.*

The major subjects covered are: Highways, Water Supply, Sewerage, Refuse Collection and Disposal, Street Cleaning, Bridges, etc.

Vol. 61 October, 1930 No. 10

Table of Contents

Airports
Location of Airports 63

Book Reviews 6

Construction Equipment 82

Editorial Notes 35

Engineering Societies 79

Flood Control
Levee Construction by Tower Machines in the Yazoo District 29

General
Cement Specifications Revised by A. S. T. M. 24
Essentials of Engineering Contracts. *By James H. Griffin* 31
Unsuccessful Bidders Paid for Bidding 39

Highways and Pavements
Laying 5½ Miles of Pavement in 34 Working Days 19
Economics of Highway Design. *By A. G. Bruce* 33
Rental of Highway Machinery 44
Relocation and Paving Along New York Route 17 47
Painting Creosoted Guard Fence Posts 50
Culvert Pipe for State Highways 52
Tandem Pavers in Concrete Road Construction 56

Industrial Literature 93

Legal Decisions for the Engineer and Contractor
By John Simpson 59

Refuse Disposal
Charlotte's Refuse Incineration. *By H. W. Lincoln* 23

Sewerage and Sewage Treatment
Barrington Sewage Treatment Plant. *By E. Bender* 21
Two Activated Sludge Plants in Japan. *By Tsunejiroh Kawahara* ... 36
Recent Kansas Sewage Treatment Plants 44
Sewage Treatment at Gilroy, Calif. 63

Snow Removal and Drift Prevention
Road Location and Design for Snow Drift Prevention. *By Walter Schultz* 25
Combating Snow in Carlton Co., Minn. *By N. C. Nickerson* 28
Drift Prevention on North Dakota Highways 28
Snow Removal Costs 55 Cents per Motor Vehicle 50

Water Supply and Purification ....
Small Town Averts Shortage Due to Drought. *By A. E. Clark* 27
Waterworks or Fire Engines for Small Town Fire Protection. *By Collins Wight* 39
Dropping a Dam into Place 40
Welding Cast Iron Water Mains 42
Eliminating Suspended Matter from Water 55
Water Softening at Iola, Kans. 56

With the Authors 4

Who Has Had Experience?

Col. J. F. Siler, chief health officer of the Panama Canal Zone, who is an old army friend, visited our office the other day, and asked us to aid him in securing operating data on the grid type of incinerator, used to a considerable extent by the army during the war, and since then at some of the army posts. This is used mainly for refuse incineration, but for manure disposal, as well, at some places.

It will be appreciated if anyone, who has had experience with this type of equipment, on either refuse or garbage, will give the editor information as to his success or failure. There are some places on the Canal Zone, where some difficulty is being encountered in refuse disposal, and Col. Siler is gathering information on the subject while on leave of absence.

Please send us your experiences promptly, as Col. Siler will return to Panama about the middle of October.

For the Mathematician!

Jerry Kavanagh from Chattanooga was in the office the other day, and sprung this one: "There are three paper bound books of 300 pages each, including covers, on a shelf, Vol. I, II, and III, arranged in proper order, left to right. Each book is one inch thick. A bookworm starts in on page 1 of Vol. I and eats his way through to page 300 of Vol. III. What is the shortest distance through which he must eat his way?"

A year's subscription to PUBLIC WORKS to the man that first sends in the correct answer. Or woman, either. Address THE EDITOR.

Now Is the Time

Now is the time to get ready for conventions. The American Society for Municipal Improvements meets this month in Richmond, Va.—the 13th to 17th. You hadn't ought to miss the convention; and, anyway, Richmond is a beautiful city, well worth visiting. And the American Road Builders' Association Convention and Road Show is going to be held in St. Louis in January. Charley Upham is getting up a program even better than last year's. Mark that date now—January 12—17—and don't let anything interfere with your going.

J. T. MORRIS
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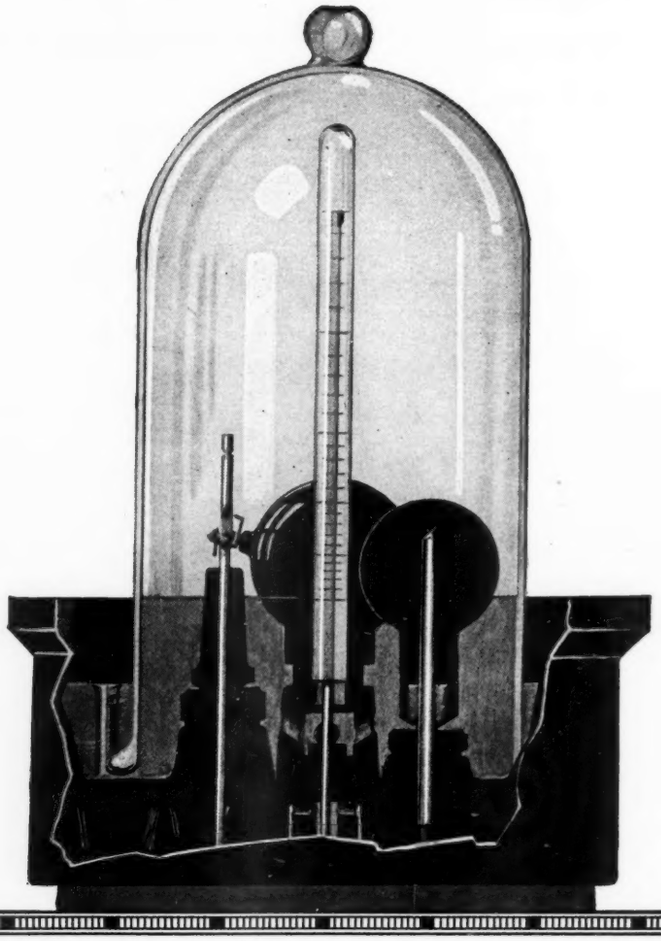

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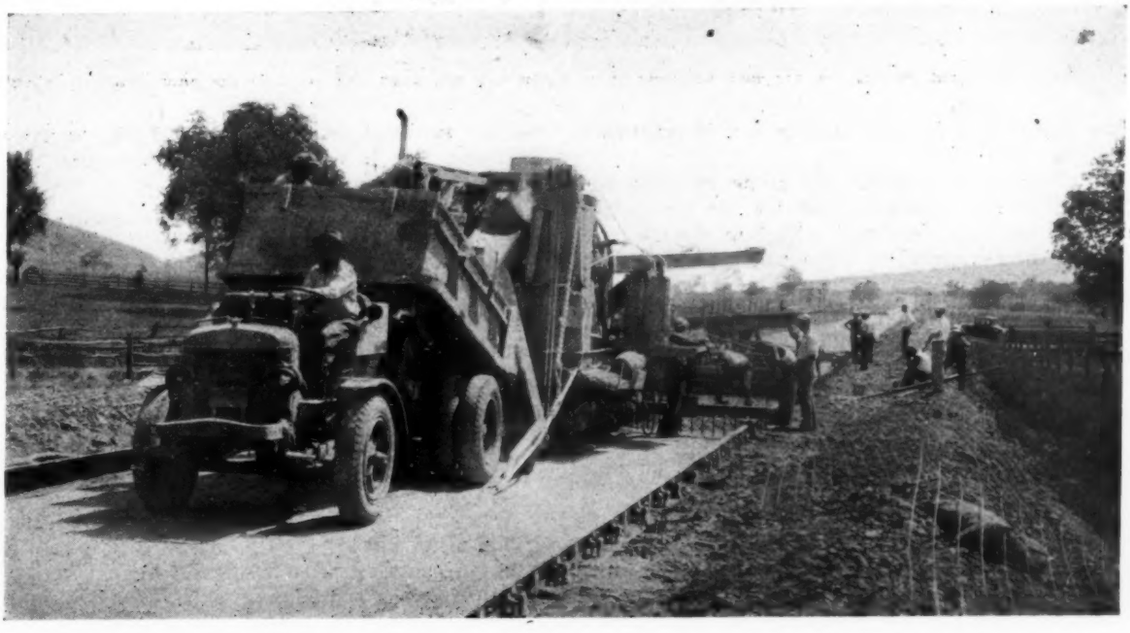
PUBLIC WORKS

CITY COUNTY STATE

AN ENGINEERING AND CONSTRUCTION MONTHLY

Vol. 61 October, 1930 No. 10



It may not look it, but this mixer was laying 80 feet of 18-foot, 8-6-8 pavement per hour the day this was taken. Good organization is the answer.

Laying Five and One-Half Miles of 18-Foot Concrete Pavement in 34 Working Days

THE basic principles in quantity production of concrete pavement were outlined by P. M. Tebbs and C. H. Buckius in the August and September issues of PUBLIC WORKS, and some interesting data were presented regarding the rate of construction of concrete pavements on the various paving projects in Pennsylvania.

The application of these principles of quantity production of concrete pavement is well illustrated by the Sherman & Rhodes contract, in Snyder County, Pa., near Beaver Springs. This contract involves no grading, this having been done on a previous contract, but is for laying 5.46 miles of 18-foot, 9-7-9, concrete pavement. The pavement is the Pennsylvania standard type, mesh reinforced and calcium chloride cured, with a 1:2:3½ mix. Sherman & Rhodes, finding that their mixer would be idle for a 6-week period between paving work on two contracts already secured, bid in this job of paving with the intention of completing the work within that period.

To date, the necessary average has been maintained and more. On August 4th, 1120 feet of pavement 18 feet wide was placed in a working day of 13 hours, a total of 2240 square yards, and an average of 172 square yards or 86 lineal feet per hour. The average weekly run has been somewhat more than a mile.

The equipment and labor on the job are the same as on the average paving job. The mixer is a 27-E Koehring. The aggregate is loaded at the batcher, which is made by Johnson, by a Northwest 1-yard crane, and hauled by 3-batch Autocar trucks to the job. There are an average of 32 men on the mixer gang. The illustrations, taken while the mixer was running better than 80 feet per hour, show the men are not "hustling" in the usual sense of the word. Other equipment also represents standard units: a Lakewood screed; Hotchkiss forms; and a Flexible Joint machine for installing the center joint. A hand strike-off was used (though the mechanical is better and faster); Solvay calcium chloride, National Steel

Despite the record speed on this job, the men had time to sit down now and then, and to watch the photographer do his stuff.

Fabric reinforcement, and Philip Carey expansion joints also were used.

The answer to this output lies in the methods used by David Owens, superintendent for the contractors. This outfit has been consistently high in the efficiency records of the Pennsylvania Department of Highways. For the week ending July 31, it was No. 1, with 91.3% of possible time utilized, and an average of 39.05 batches of concrete per working hour. When the illustrations shown herewith were made, the mixer was running close to 38 batches an hour. Only five motor trucks were hauling batches, but despite a grade crossing (a truck can be seen at the left of one illustration waiting for the crossing to clear) there was no delay to the mixer.

Every effort was made to keep the mixer working at maximum speed, and all other activities were made secondary to, or coordinated with, this mixer speed. There was no lost time in moving—to lose a batch on every move of the mixer means a reduction of 10% to 12% in mixer output. Actually, as has been pointed out by Mr. Tebbs, the mixer operator is the most important workman on the job, second only to the management that is responsible for providing him the essentials of material for operation.

The essentials in mixer operation to secure this output included:

Quick lowering and immediate filling of the skip. The trucks were allowed to pull away only a short distance after dumping their first and second batches, so there was no delay in getting back to dump another batch.

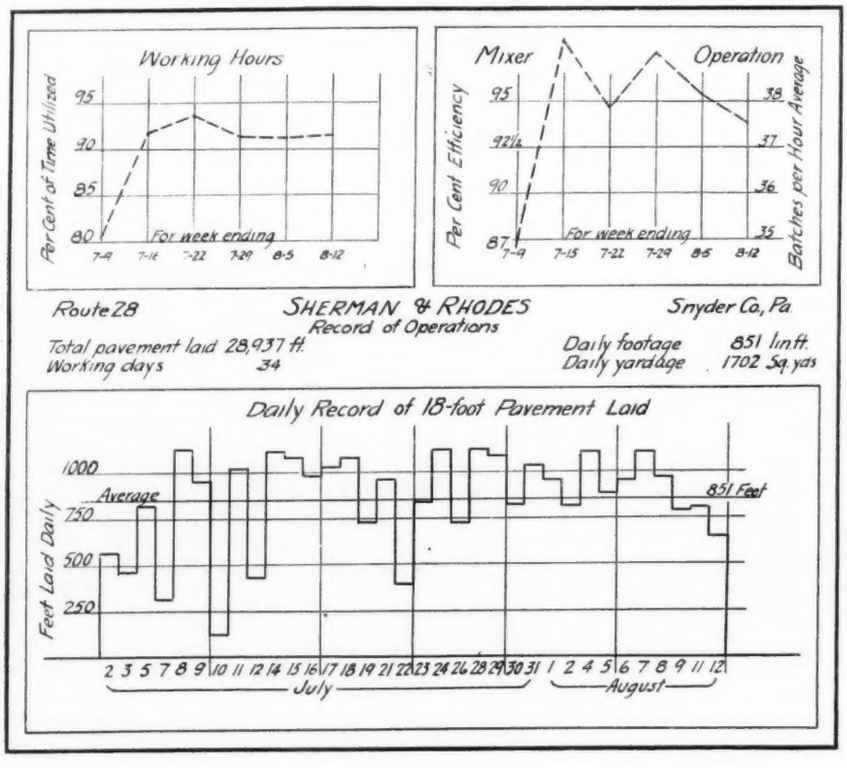
Just as soon as the bell rang indicating completion of mixing time, the concrete was discharged and practically simultaneously the skip was raised to recharge the drum.

When the bucket was full, it was dumped, the subgrade tester having been used and that section of the subgrade farthest from the mixer having been tested and properly prepared first, so as to allow immediate deposition of the concrete. The men in the pit kept out of the way of the bucket, thus allowing prompt discharge of it. Experience has shown that an occasional workman may forget to move out of the way of the bucket, but after having a yard of wet concrete bumped into him, the same man rarely forgets twice.

The mixer operates while moving, and the first batch after moving is always deposited in a particular location. In fact, so far as is possible, the same general plan of dumping is followed after each move. A batch is never split, as it is recognized that splitting a batch is practically losing a batch.

By providing a plentiful flow of material through good management and then insisting that his mixer operates as nearly continuously as is humanly possible, Mr. Owens approximates the theoretical maximum quantity production of concrete pavement.

B. W. Yarrison is chief inspector on the job, and Jesse S. Ritchey, Williamsport, Pa., is division engineer.



Barrington Sewage Treatment Plant

Continuation from September issue of article describing plant where clarified sewage is treated by mechanical aeration, and settled effluent is filtered through sand and chlorinated. Sludge digestion tanks and glass-covered drying beds.

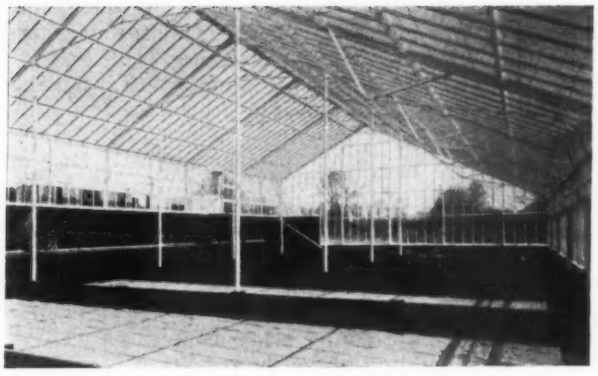
By E. Bender
Roberts Filter Mfg. Co.

THE effluent from the final settling tanks is filtered through sand filters at the rate of 1½ gallons per square foot per minute. There are four filter units in concrete boxes, each 7 ft. by 10 ft. by 8 ft. deep, provided with a cast-iron manifold and covered with 18 in. of graded gravel and 27 in. of sand; the gravel consisting of a bottom layer 5 in. deep of 2½ in. to 1 in. gravel; a second 4 in. deep of 1 to ⅝ in.; then 4 in. of ⅝ to ⅜ in.; then 3 in. of ⅜ to 3/16 in.; and finally from 3/16 in. to 10 in. mesh.

The sand has an effective size of .35 to .55 millimeters with a uniformity coefficient of 1.7.

The manifold running lengthwise of each box has a cross section area of 53.3 sq. in. and is provided with bosses tapped for 2 in. pipes placed 6 in. between centers and 2¾ in. from the filter floor. In each boss is inserted a 2-in. wrought iron lateral capped on the outer end and provided with fourteen ¼-in. holes, giving a total strainer area in each unit of approximately 28.5 square inches, or .28 per cent of the total sand bed area.

On the top of the manifold, set 6 in. between centers, are brass umbrella-type strainers. Between the bosses a brass orifice strainer is inserted in the manifold flush with the filter floor, for draining the water out of the filter when desired. At the rear end of each manifold an air-relief pipe is carried up through the gravel and sand to the level of the operating floor and valved there, to relieve any air which might accumulate in the underdrainage system.

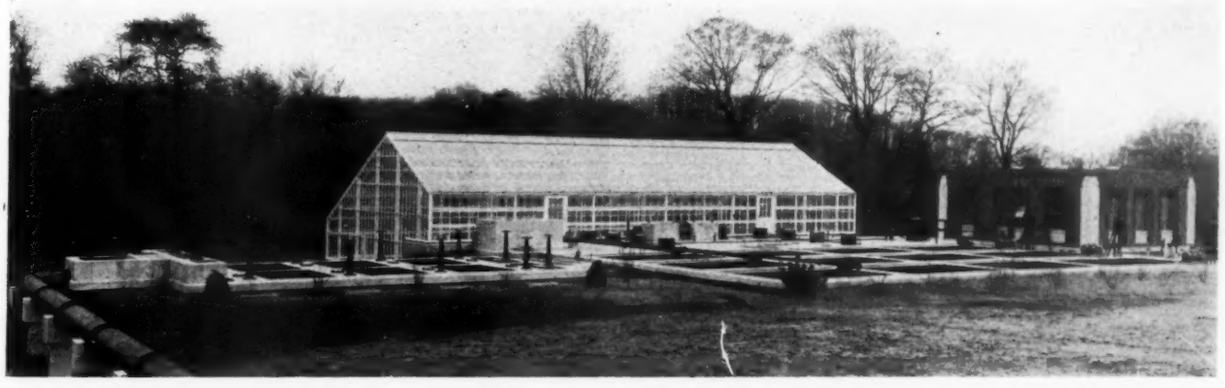


Interior View of Sludge Beds.

In the center line of each unit is a cast iron V-shaped wash gutter, the lip of which is 22 in. above the top of the sand; the cross sectional area of the gutter being 202.5 sq. in. The gutters taper upward toward the rear end of the filter, where the tank effluent is admitted to the filter through a 6-in. gate. These valves, as well as the valves on the 4-in. effluent line, the 8-in. wash water line and the 10 in. waste line, are operated manually by means of floor stands on the operating floor.

Each filter effluent line contains a Simplex rate-of-flow controller, all of which are connected to one 8-in. header, which is carried to the inlet end of the contact or chlorinating tank. Each controller is provided with an automatic device for closing it should the level fall below the wash gutter lip. As a matter of precaution, each unit is provided with a 4-in. overflow discharging to the chlorinating tanks. Each unit also is provided with a Simplex indicating and recording loss-of-head and rate-of-flow gauged, mounted on the operating floor.

Wash water is taken from the contact tank, after chlorine has been applied, by means of a 1,000 g.p.m. Jennings horizontal centrifugal pump direct connected to a 7½ H.P. motor, which provides wash water at the rate of approximately 15 gallons per sq. ft. per



General view of plant. Sewage enters grit chamber through iron pipe at left. At the right of these, preliminary settling tanks; then aeration tanks, in front of glass-covered sludge beds. At extreme right, filter house. Sludge digestion tank, with gas domes, lies between aeration tanks and sludge beds.

minute. Under the four filter units and along one end of the pipe gallery is a concrete wash-water storage basin into which the wash water is discharged when the filter is being washed, from which it is automatically pumped and discharged through a 4-in. cast-iron force main into the grit chamber, to pass again through the plant. The pumps used for this purpose are two 25 g.p.m. Jennings suction sump pumps operated by float switches, self-priming, horizontal centrifugal units direct connected to a 2 H.P. motor. The pumps start automatically whenever the water reaches a predetermined level. A Foxboro air-operated gauge indicates the depth of water in the storage basin, the recorder being mounted on the wall of the filter building above the operating floor. The waste from the laboratory and lavatory is raised by a 30-gallon Jennings pneumatic sewage ejector, which discharges it into the force main from the two sump pumps.

A chlorinator room is located at one end of the pipe gallery, in which a Wallace and Tiernan vacuum type chlorinator is installed, with a 1,000 lb. platform scale. The chlorine is applied to the filter effluent in the contact tank. A telescopic hoist is provided for raising and lowering the chlorine drums.

Two Nash Hytor rotary air compressors are located on the pipe gallery floor and supply air to the six pieces of air lift apparatus in the final settling tanks, two in the separate sludge digestion tanks and two in the sludge rising wells. Each compressor has a capacity of approximately 100 cu. ft. of free air per minute at 8 to 12 pound pressure. An air receiver 3 ft. diameter and 6 ft. high is provided.

On the filter operating floor is mounted a slate switchboard with an incoming panel 18 in. wide by 6 ft. 8 in. high carrying a voltmeter, ammeter and circuit breaker. The distributing panel is 30 in. wide by 6 ft. 6 in. high and carries twelve knife switches operating motors for the three aerators, two air compressors, one wash water pump, two wash water return pumps, one sludge collector, and one sewage ejector and two for the lighting circuits. Also there are five push-button switches operating the three aerator motors, one wash water pump motor and one sludge collector motor.

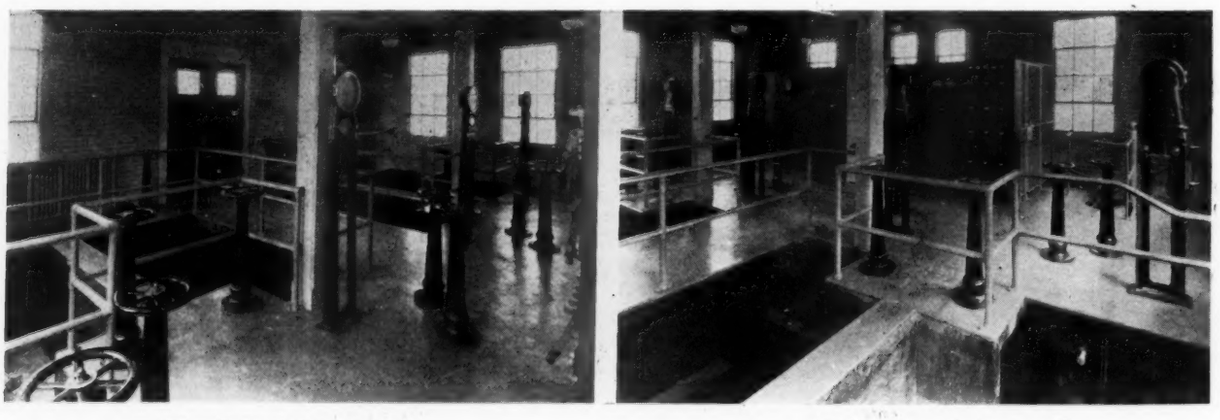
Separate Sludge Digestion Tanks

There are two sludge digestion tanks, each 26 ft. by 29 ft. 6 in. by 9 ft. deep, provided with a series of round-about wooden baffles, with a 2 in. brass perforated spray pipe at the flow-around end of each baffle. Each tank contains a heating coil six inches above the floor, consisting of 2 in. wrought iron pipe supported on cast iron floor clamps. In one corner of each tank is a 6 ft. by 6 ft. hopper-shaped sump 2 ft. below the floor, from the bottom of which rises a 6-in. cast iron vertical pipe, at the bottom of which is a brass-lined air lift, which pipe continues vertically through the roof and carries at the top a 6-in. cast-iron dome which deflects the sludge down into concrete boxes 2 ft. 6 in. by 3 ft. 6 in. Branching from this pipe below the level of the sewage is an 8-in. pipe extending through the wall into a flume which carries the sludge to the drying bed. The sludge is discharged into this flume by hydrostatic pressure.

The air lift is used to carry sludge up to the top of the pipe and into the concrete box mentioned, from which box a 6 in. pipe carries the sludge to either of two manholes, one in each tank, the walls of which project down into the sludge 5 ft., below the roof slab. By this means sludge can be drawn from the bottom of either tank and used to seed the incoming sludge, or to circulate the sludge in the tanks for digestion. On the roof of each tank are four 24-in. diameter cast-iron gas domes used for collecting gas. Opposite each gas dome a 10 in. cast-iron inspection and sampling pipe is set in the roof slab and closed with a cypress plug.

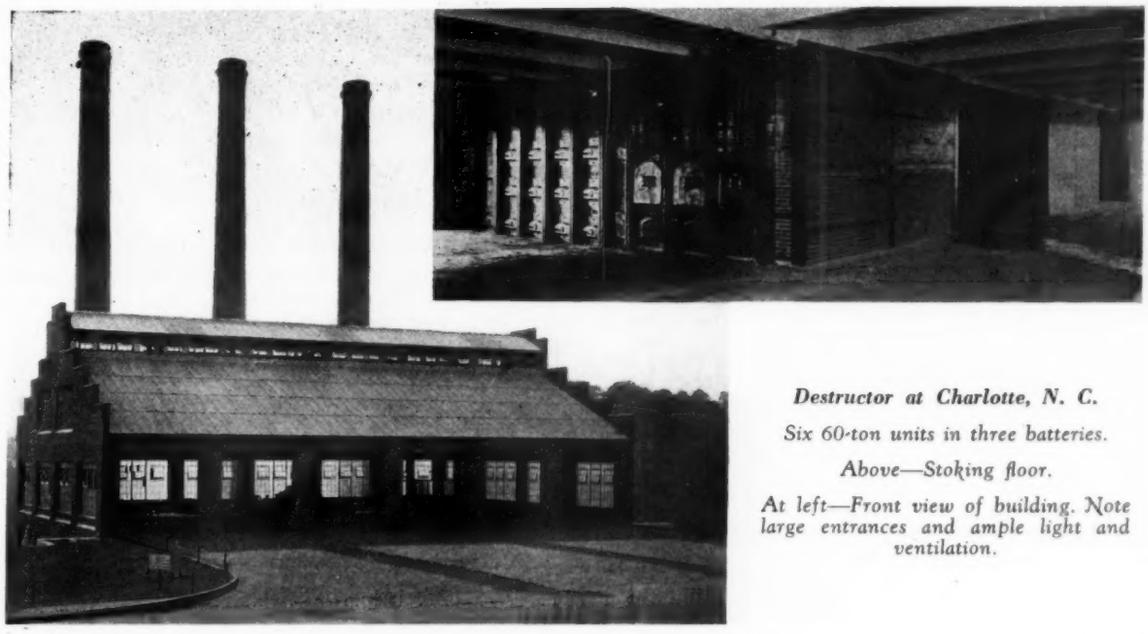
Each tank is provided with a decanting valve for drawing off liquid, from any elevation in the tank desired, into an inspection box located in the sludge drying bed. This consists of an 8 in. brass pipe extending from the roof to the floor of the tank, in which is a slot 2 in. wide and 7 ft. long. Inside of this pipe slides a 7 in. brass pipe in which are 7 slots, each 2 in. wide and 6 in. high and arranged spirally around the circumference 6 in. apart vertically. Thus, by revolving the inner pipe it is possible to bring any slot desired in this pipe coincident with the slot in the outside pipe, thus drawing off the liquid at any desired depth within a range of 7 ft. A pointer at the top of the inner revolving pipe and number plates on a floor stand on the roof indicate which of the several inner slots is coincident with the outer slot. A 4 in. pipe branches from the outer pipe, passes through the wall of the tank and empties into a 24 in. square inspection box in the sludge drying bed.

(Continued on page 69)



Filter Units, Valve Stands, Etc. *Switchboard in the Rear*

Interior View of Filtration Plant.



Destructor at Charlotte, N. C.

Six 60-ton units in three batteries.

Above—Stoking floor.

At left—Front view of building. Note large entrances and ample light and ventilation.

Charlotte's Refuse Incinerator

Six units in carefully designed building replace dumping of garbage and dispose of refuse, which increased twenty per cent with introduction of regular collections.

By Herbert W. Lincoln
Morse Boulger Destructor Company

ON August 1st, Charlotte, N. C., had been operating for a year a new refuse incinerator which not only eliminated the nuisance of the previous dumps, with their odors, rats and fire hazard, but apparently reduced the cost of disposal. Previous to this only a small part of the refuse was burned in an incinerator designed by the city's engineers some years before, which had become totally inadequate in size and needed to be shut down for repairs, the greater part of the refuse being dumped. The dumps created such a nuisance that the city was threatened with lawsuits by adjacent property owners, and in the spring of 1928 the city commissioners decided to obtain an incinerating plant capable of disposing of all the city's refuse for some time to come.

The daily collection of refuse varied from 80 to 100 tons, from a population of about 80,000, or a little more than two pounds a day per capita which is considered a general average; the excess being attributed to the fact that Charlotte is a marketing and distributing center for a large surrounding territory. It was decided, therefore, to obtain a plant capable of destroying 120 tons in an eight-hour day.

The city wished to obtain bids on at least three widely different types of incinerators represented by the eight or nine incinerator manufacturers who might bid. Detailed specifications written to describe one type would exclude the others, and some companies favored the installation of many auxiliaries such as forced draft, preheaters, ash handling equipment, etc., while others favored as simple a plant a possible; therefore the specifications were made as simple and general as possible, as follows:

The incinerator must consist of two or more furnaces of modern approved type with a combined guaranteed capacity of 120 tons of average city run garbage, rubbish, waste trash, dead animals, etc., for an eight-hour day and to be housed in a fire-proof building with reinforced tile roof and radial brick chimney not less than 100 feet high.

Bidders will be required to furnish complete plans of furnaces and building they propose to erect, and a list of not less than five similar incinerators in operation at the time of filing bid that have been successfully operated for one or more years.

Four bids on the basis of these specifications were opened on August 29th, 1928, representing the three major types of plants. These, with the accompanying plans and specifications, were turned over to a firm of consulting engineers which was employed to analyze them, inspect the plants given as references, and make recommendations.

Particular attention was paid to the type and size of building recommended, for it would be necessary

that 160 loads of refuse be delivered in eight hours, or an average of one every three minutes, since the trucks used for collecting averaged only about 1500 pounds capacity; and any delay in passing these trucks into and out of the plant or in unloading them would cause congestion and consequent additional cost of collection due to loss of time. This required ample floor space and entrance and exit facilities. The most abundant light and ventilation also were considered important.

Another feature considered important was that the plant contain a sufficient number of units to secure flexibility of operation and that each unit should operate at high efficiency, whether deliveries be light or heavy.

Since the plant would be operated with negro labor, which is willing but not of a high degree of intelligence, it was thought best to employ a plant with a minimum of mechanical equipment and one in which the labor is confined to charging and stoking and removing ashes.

The contract was awarded to the Morse Boulger Destructor Co. Owing to delay in selection and purchase of site, construction work did not begin until February, 1929. The plant was completed and tested and taken over by the city on August 1st, and has been in continuous operation since then.

The site selected was on the edge of the city and included a sufficient area of low ground to permit dumping incinerator cinders on it at low cost for many years, and ample room for additions to the plant when needed. The building has a floor area of 72 ft. by 105 ft. 8 in., or 7600 sq. ft., and is provided with six large doorways, closed by rolling steel doors. It is built partly on a side hill so that vehicles can enter the upper floor almost at road level, and ashes can be removed in wheelbarrows from the stoking floor at the rear without use of a ramp or trestle. The city constructed a road with improved surface from the nearest paved street to the plant.

The incinerator consists of six units, each with a guaranteed capacity of 60 tons in 24 hours, connected in pairs to three stacks. Each unit has its own settling chamber and damper and can be operated entirely independent of the others. The stacks are 125 feet high and 5 feet inside diameter at the top and were designed to provide ample draft under conditions of maximum load without the need of any draft fans.

The contract provided for an acceptance test and a guarantee that the plant would operate without nuisance when burning 15 tons per hour of city refuse, taken for the purpose of the test as consisting of 70 percent garbage and 30 percent rubbish, the garbage to contain not more than 65 percent moisture; and that an average temperature of at least 1250° F. be maintained in the combustion chamber without the use of any fuel.

The plant was tested by batteries on three days under the supervision of the city engineer and a consulting engineer. The collection service had not been organized, and the refuse delivered to the plant contained less than the specified proportion of rubbish; also the operating personnel were largely inexperienced. However, the units operated during the test at 10 percent in excess of the guaranteed capacity, and have continued to burn an average of 120 tons a day, running as high as 146 on peak days. As in all southern cities, the garbage is very wet during the watermelon and green vegetable season, but no coal has been used at any time since the collection service became established systematically.

At about the time the plant was completed the government of the city was changed to the city manager form and a Division of Sanitation was established to take care of the collection and disposal of all refuse and cleaning the streets. One of the first steps taken to improve the collection system was to draft ordinances prescribing the types of receptacles to be used for garbage, rubbish, and ashes; the times of collection, and other details. The carrying out of these very materially increased the amount of rubbish collected, for formerly the residents had not set their rubbish out regularly for collection. As a result, not only is more matter present in the refuse to aid combustion, but there is a general improvement in the appearance of back yards and alleys. The total amount of refuse collected has increased 20 percent.

Cost records are kept by the calendar year, and those of this plant are therefore available only for the last five months of 1929. During that time the average cost of disposal was 44.8 cents per ton (presumably for expenditures only, with no allowance for overhead, interest, depreciation, etc.) The regular crew consists of one superintendent, and eight laborers charging furnaces, stoking, removing ashes, etc. The budget for this service this year is about $21,000 less than previously, partly due to unified supervision of all collection and disposal, partly to various savings such as reduction in cost of maintenance of trucks since the dumps were discontinued.

Cement Specifications Revised by A.S.T.M.

The members of the American Society for Testing Materials, by a vote canvassed in September, have adopted the revisions proposed by Committee C-1 in the Standard Specifications and Tests for portland cement. Of the eleven items in the revision, nine were concerned with tolerances for testing apparatus; the other two increasing strength requirements for standard cement.

The average tensile strength at seven days for the three standard mortar briquettes is increased from a minimum of 225 pounds to 275 pounds, and for the 28-day briquettes from a minimum of 325 pounds to 350 pounds. The committee reported that tests by 116 plants during the latter half of 1928 showed only a small percentage of samples failing to meet these proposed strength standards.

Specifications for high early strength portland cement were accepted for publication as tentative by the society's Committee E-10 on Standards, at its February 1930 meeting. Tentative specifications are the same as the newly revised specifications for portland cement, except that a maximum sulfuric anhydride content of 2.5 per cent instead of 2.0 per cent is permitted and that tensile strength requirements shall be 275 lb. per sq. in. at one day, and 375 lb. per sq. in. at three days. In addition, the purchaser has the option to require a test at 28 days in which case the average tensile strength obtained shall be higher than the strength at three days.

Illustrating evil of narrow, shallow cut.

Plowing with high-speed light unit.

Use of heavy equipment necessary.

Road Location and Design for Snow Drift Prevention

Location in valleys and on the windward side of slopes. Raising roadbed above surrounding country. Wide and shallow cuts. Snow fence easement.

By Walter Schultz

Locating Engineer, Dept. of Highways, Minnesota

IT is obvious that we cannot prevent snow, but from the standpoint of highway construction, it is quite practicable, in a measure at least, to avoid, eliminate, minimize, or control the effects of drifting snow.

This may be accomplished in several distinct ways; first, in location, whereby the line is fitted to the topography in such manner as to avoid situations where drifts habitually form; second, in design, whereby the use of an elevated grade line, wide ditch sections and flat slopes, eliminates or minimizes the causes; and third, by protection, for example, the use of snow fence for controlling effects.

The problem properly begins with location. What is not accomplished in the way of prevention at this time may be taken care of by design. What is left undone by design will have to be taken care of by maintenance.

No attempt will be made to discuss the subject as it pertains to mountainous regions where deep accumulations of snow and ice give rise to conditions that do not obtain in Minnesota. Here, however, there is a variety of topographic conditions which should be fairly representative of large areas in the states comprising the Snow Belt.

At one extreme are the flat prairies of the Red River country; at the other, the deep, winding valleys of the southeastern section. Then there are the rugged hills of the Lake Superior region and the timbered lands of the northern portions, while between ranges a country that is rolling to varying degrees.

Prevention by Location

A valley route, if it be sheltered, affords the best natural protection for a highway. Under these conditions, the formation of drifts may be reduced to a minimum and an open road assured for traffic every day throughout the winter. The ideal situation, however, obtains on a rather limited mileage in this state. Wherever practical, a location in a valley may afford advantages that are valuable because of saving in snow removal.

In the northern section of the state the timbered lands still afford a great deal of protection to the highways from drifting snow. The annual saving resulting from decreased snow removal costs could probably be capitalized at quite a sum. Land clearing operations for agricultural purposes are slowly diminishing the timbered areas. The effective way in which timber adjacent to a highway may prevent the formation of snow drifts suggests the desirability of measures to promote the preservation of such timber. In regions where timbered lands are of low potential value from an agricultural standpoint, it is conceivable that a workable plan of acquiring strips of sufficient width adjacent to the highway on the sides from which come the prevailing winds, could be evolved, and maintenance thereof on a practical forestry basis obtained through co-operation with the forestry department of the state.

These two instances indicate the great value of natural protection to a highway from the effects of drifting snow, but even in Minnesota their beneficial effects extend to a relatively small portion of the state system.

There remains to be considered the adaptation of line to topography in open rolling country in such manner as to reduce the effects of drifting snow. In this state it can easily be observed that the prevailing winds which cause drifting come from the northwest quadrant, with a tendency to deposit snow on the leeward (southeasterly) side of all slopes. This fact is fundamental. It enables us to confine our efforts at prevention to one quarter, as it were. If these winds came well distributed from all points of the compass, it would, for instance, be necessary to erect snow fence on both sides of a road instead of one. (A road with a northwesterly-southeasterly direction may still require protection on both sides on account of the wind

swinging through such a large arc in the northwest quadrant and thus causing drifting from both sides.)

This characteristic of drifting from the northwest suggests at once that a highway might be so located as to avoid the leeward side of all slopes where lodging of drifts habitually occurs. This of course pertains to rolling country. If it were the only factor that entered into the problem, in many cases, a very effective job of dodging drift places could be accomplished. However, in actual practice many other considerations than that of snow prevention may control the location. Chief among them are the surveys of the public lands, which in this state were based upon the rectangular system. Thus, through the years, roads came to be built upon the section lines, regardless of the fitness of the topography and generally with little thought of what might be the effects from drifting snow. In this manner, we inherited a system in which the rights of the land owner were paramount. During recent years public opinion is supporting more and more the principle of eminent domain whereby, when the interests of the public highway and those of the individual land owner conflict, the former prevail. When rights-of-way are so acquired across private lands, however, it is generally done from considerations of saving of distance, and from the requirements of alignment rather than of snow drift prevention. In other words, the cutting of private property can be justified for the purpose of saving distance, or to secure adequate alignment, but it may be too costly for the purpose of snow drift prevention. A line adapted to the topography in a manner to adequately avoid snow drifts may be too long or too crooked to meet modern requirements, and the right of way may be so expensive as to be prohibitive.

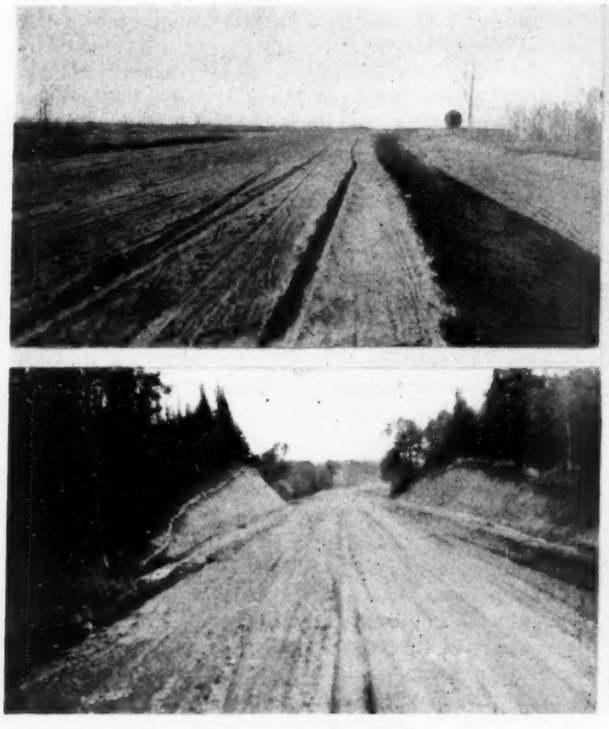
Thus it is seen that snow drift prevention by adaptation of line to topography in rolling country may be rather limited in its scope. The foregoing discussion indicates that the problem of snow drift prevention from a broad sense, as it pertains to a highway system, may be only partially solved through the medium of location. After all practical measures have been taken to avoid the effects of drifting snow through proper location, it is still feasible to eliminate or to minimize its effects through proper design.

Prevention by Design

Design for snow drift prevention finds its simplest application in flat or gently rolling country. Here the problem is to raise the grade line above the level of the surrounding land surface, or more properly, perhaps, above the level of the snow surface. Suppose, under these conditions, a grade line is laid to average about one foot above the general ground surface. With a 40 foot road bed and assuming for the purpose of this discussion a shrinkage factor of 25% this cross-section will require about 10,500 cu. yds. of fill per mile. So long as the snow plane remains below grade, the road bed should be kept fairly free of drifts by the sweeping action of the wind. Let the snow plane rise above this grade, however, drifts will begin to form and trouble will begin, and if the road is to be kept open, snow removal and control by snow fencing would have to be resorted to.

To raise the road bed 0.5 of a foot would require roughly about 5,000 cu. yds. of additional material per mile. At 30 cents per cu. yd. (including haul), this would amount to about $1,500. Interest on this amount at 5 per cent would be about $75. With the annual charges against snow fencing running around $250 per mile, besides the cost of snow removal and loss to traffic during snow blockade, would this additional in-

(Continued on page 70)



Above—Illustrating design in flat and gently rolling conntry.
Below—Illustrating value of protection by timber.

Above—A "protected valley" route.
Below—Illustrating design in shallow cuts.

Small Town Averts Water Shortage Due to Drought

Temporary use of well water high in mineral content and possibly in bacteria

By A. E. Clark

Assoc. Sanitary Engineer, Tennessee State Dept. of Public Health

LAFOLLETTE, Tenn., is located about forty miles north of Knoxville, in the coal mining section. Its population is about 3,000. The water system is owned by the Tennessee Electric Power Company. The water supply is normally obtained from an impounding reservoir holding approximately 23 million gallons at spillway level. It flows by gravity to a purification plant consisting of aeration, coagulation, sedimentation, filtration and disinfection. Nearly all of the town can be supplied by gravity from this plant, but for elevated storage and a supply of the higher points a 125 g.p.m., motor-driven centrifugal pump is used. About 130,000 gallons of water is stored in two standpipes, one located near the purification plant and one on the opposite side of town. Water is conveyed to the town through 8,000 feet of 8-inch cast iron main.

Previous to the construction of the purification plant, the town was supplied by gravity and the water chlorinated. During the warmer months of the year there was considerable dissatisfaction due to color and taste and odor due to algae growths in the reservoir, making the water very unpalatable. Through this period, drinking water was obtained from local springs. It was difficult to procure new consumers and probably less than 50 per cent of the population had taps. Following the installation of the filtration plant, complaints ceased and the number of taps has been considerably increased, totaling about 400 taps at the present time.

During the latter part of July of this year it became apparent that, unless some relief was obtained very shortly by rains, the shortage of water would become acute, and a survey was made in order to locate an additional supply from springs, but none were found of sufficient size to warrant connecting to the system. On September first the town was practically out of water with the exception of about 100,000 gallons in the standpipes, which had been cut off and were being held in reserve in case of fire.

Consideration was then given to a well located near the purification plant and formerly owned by the LaFollette Coal and Iron Company, which has ceased operations. This is a 10-inch well approximately 1,200 feet deep and was used by the company in its operations. Before the filtration plant was built there was some thought given to the use of water from this well for the town supply, but the mineral content shown by analysis was such that it would not be satisfactory without treatment, and with treatment the cost would be prohibitive. The sample analyzed contained considerable reddish brown matter in suspension, and 43.3 p.p.m. CO_2 dissolved in the water. The quantity of solid suspended matter, after dehydration and oxidation, amounted to 29.7 p.p.m., consisting of Silica 21.9 per cent; Ferric Oxide 77.1 per cent. The water after filtering, showed:

	p.p.m.		*p.p.m.*
Total Solids in solution	336.0	Sodium	53.4
Silica	11.7	Bicarbonate (HCO_3)	106.7
Iron	2.2		
Calcium	36.0	Sulfate SO_4	85.7
Magnesium	10.1	Chloride	38.5

The iron content is high as well as the hardness, but the necessity for water made it necessary to put it into use.

A Worthington centrifugal 125 g.p.m., pump driven by a 10 h.p. G. E. motor was brought from the plant to the well. A 3-inch suction line 18 feet long, with foot valve, was dropped into the well. It was then necessary to run the discharge line from the pump a distance of something over 200 feet to the 8-inch main going to town. A search was made for pipe and finally the discharge line was hooked up using 3-inch, 2-inch and 1½-inch pipe. While laying the discharge line, the pump had been started and was pumping to waste. The water level in the well stood 11 feet below the top of the casing before the pump was started. As soon as it was started with the discharge valve open it was evident that the draw down was going to admit air to the suction, so the valve was throttled. It was then found that it would be necessary to add more line to the suction. Another length of 3-inch pipe 22 feet long was coupled on making the foot valve 30 feet below the top of the casing. As soon as the connection had been made to the main, the pump was again started with the valve partially closed and as the mains filled and produced back pressure it was opened. The draw-down was

(Continued on page 64)

Pump, discharge line and chlorinator at well.

Combating Snow in Carlton County, Minn.

By N. C. Nickerson

Highway Engineer for Carlton County

SNOW removal in this section of the country is not the problem that it was several years ago. This is due to the fact that better methods have been adopted in combating the snow and better equipment is available. Furthermore, snow fighting begins with the construction of the road, and new roads are now built higher than the adjacent fields so that the snow will blow off from the road instead of on to the road. The ditches, too, are designed so that the outside slope will not start a drift, a two-to-one slope being sufficient for this purpose. These new roads as well as the old roads are now kept free of grass and brush, especially along the windward side, so that these obstructions will not cause a drift to start. In cuts, the liberal use of snow fence is an efficient preventative of drifts.

Having taken the above measures of preventing snow from drifting, the actual plowing of the snow which is deposited on the road becomes an easier matter than if the wind is allowed to deposit the snow where it chooses. Fast-moving equipment which throws the snow well off from the road is used very advantageously. For this purpose 2½-ton trucks with lightweight but well designed plows have been found satisfactory. On old roads, though, especially those which are narrow and have little protection from drifts, it is necessary to use heavier and consequently slower equipment. Two trucks, in tandem, work well, or a larger truck of the four-wheel-drive type. Occasionally, too, it becomes necessary to use tractor plows to buck large drifts or to widen out roads which have a bank of snow along them left by the lighter plows for some reason or another.

This county is divided into five districts and a truck and plow is stationed in each district. As soon as a storm has stopped, the plows are sent out and they work continuously until the roads are opened. Then, when the operators have rested sufficiently, they widen out until the full width of the road is free from snow. The storms are usually of such frequency that the operators are kept busy most of the time.

During the past winter 350 miles of road were kept open at all times at an approximate cost of twenty dollars per mile, not including the depreciation of equipment. In this connection it is important to note that the same trucks and the same crews are used in the summer months on maintenance of the same roads which they keep free from snow in the winter. This gives the operators employment the year around and keeps the trucks busy the year around, as well.

The equipment used includes International 2½-ton trucks and F.W.D. 3-ton trucks used with Wausau and Sargent Model M snow plows. A "caterpillar" 60 is used with a Sargent tractor plow.

Drift Prevention on North Dakota Highways

The state highway commission of North Dakota is asking farmers to leave unplowed until next spring a strip of stubble, corn stalks or other growth of vegetation of any height next to the highway right-of-way, the unplowed strip to be 200 feet or more wide—the wided the better. This, it says, will reduce or prevent snow blowing onto the road and thus improve winter traffic conditions and reduce snow removal cost.

Says the commission in its notice:

"The stubble, corn stalks, etc., furnish protection in two ways: First, it reduces the velocity of the lower stratum of air moving over its surface which in turn reduces its carrying capacity, thereby resulting in snow being dropped. Second, it acts as a reservoir or additional storage space for the snow being moved along the surface before it reaches the road. Both of these actions reduce the formation and building up of drifts on the highway. A plowed field presents a surface over which the wind and its load of snow move uninterruptedly until an obstruction, such as a road with its accessories (right-of-way fence, guard posts and rails, cuts or submerged grade lines, etc.) is encountered, when the snow is deposited.

"This same procedure could be followed to advantage along the more important and heavier traveled county and township roads."

At the end of 1929 North Dakota had 1,622,202 lineal feet of snow fence, including the old so-called permanent snow fence, leaning panel snow fence and the newer or slat-type. A contract for 485,000 feet of additional slat-type snow fence has been awarded this year. This makes a total of a trifle over 399 miles of snow fence.

The type of snow fence used is quite effective and is easily put up and taken down. Steel posts spaced 10 feet part are used to hold the fence up, and it is not erected in the fall until the farm crops are out of the way. In the spring it is taken down early, before the farmer starts his work in the field, and is left in rolls along the edge of the highway, thus avoiding the necessity of hauling it away and storing it. The fence used by the state is painted red with the top four inches yellow. Fence for counties or other purchasers does not have the yellow top.

Plowing a badly drifted road with tractor.

Two trucks in tandem make an efficient plowing unit.

Widening road previously plowed with tandem unit.

Tower machine using six hundred-foot cable building levee

Levee Construction by Tower Machines in the Yazoo Delta

ADJOINING contract 9 on the south, and in the Central Area of the Vicksburg Engineer District, a combination tower machine and dredging job of levee construction is under way. This job, which totals about 800,000 cubic yards, consists of adding about 5,000 yards per station to the present levee, bringing the average height to 28 feet, an increase of 3 feet, and the section to the new "B" section. The total yardage of the completed levee is about 16,000 per station.

A part of this work is being done by government hired labor. U. S. Levee Machine C-9, with W. H. Deese, foreman, in charge, is putting up the levee. Since this is enlargement work, the old borrow pits offer a problem. The necessary dirt must be secured outside these pits, necessitating an average haul of 500 feet. In some places, as on curves, dirt is not available even at much longer distances.

The problem has been solved in a comparatively simple way. On the straight sections where dirt can be secured within about 600 feet of the levee crown, the tower machine is used. In those places where dirt is not available within such distance, the old borrow pits are being filled from the river bed by means of hydraulic dredges. A contract for this dredging has been awarded to the Orleans Dredging Co., which has two dredges on the job, pumping through about half a mile of line, taking the dirt from the river.

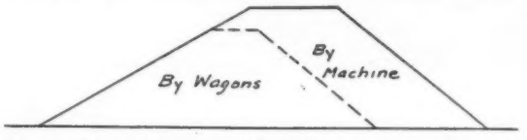


Fig. 3—Part of new levee built by wagons and part by machine

This contract requires the handling of more than 500,000 cubic yards of material, on which the contract price is 25 cents a yard.

The levee is being put up with a standard Bucyrus tower machine purchased some ten years ago. The reach is about 600 feet, all the dirt being secured from the last 100 feet. This machine with a 6-yard Bucyrus bucket, has made an excellent record. During the first 15 days of November, 1929, of which 13 were rainy, an average of 430 yards per hour was put into

Showing material added in enlarging old levees

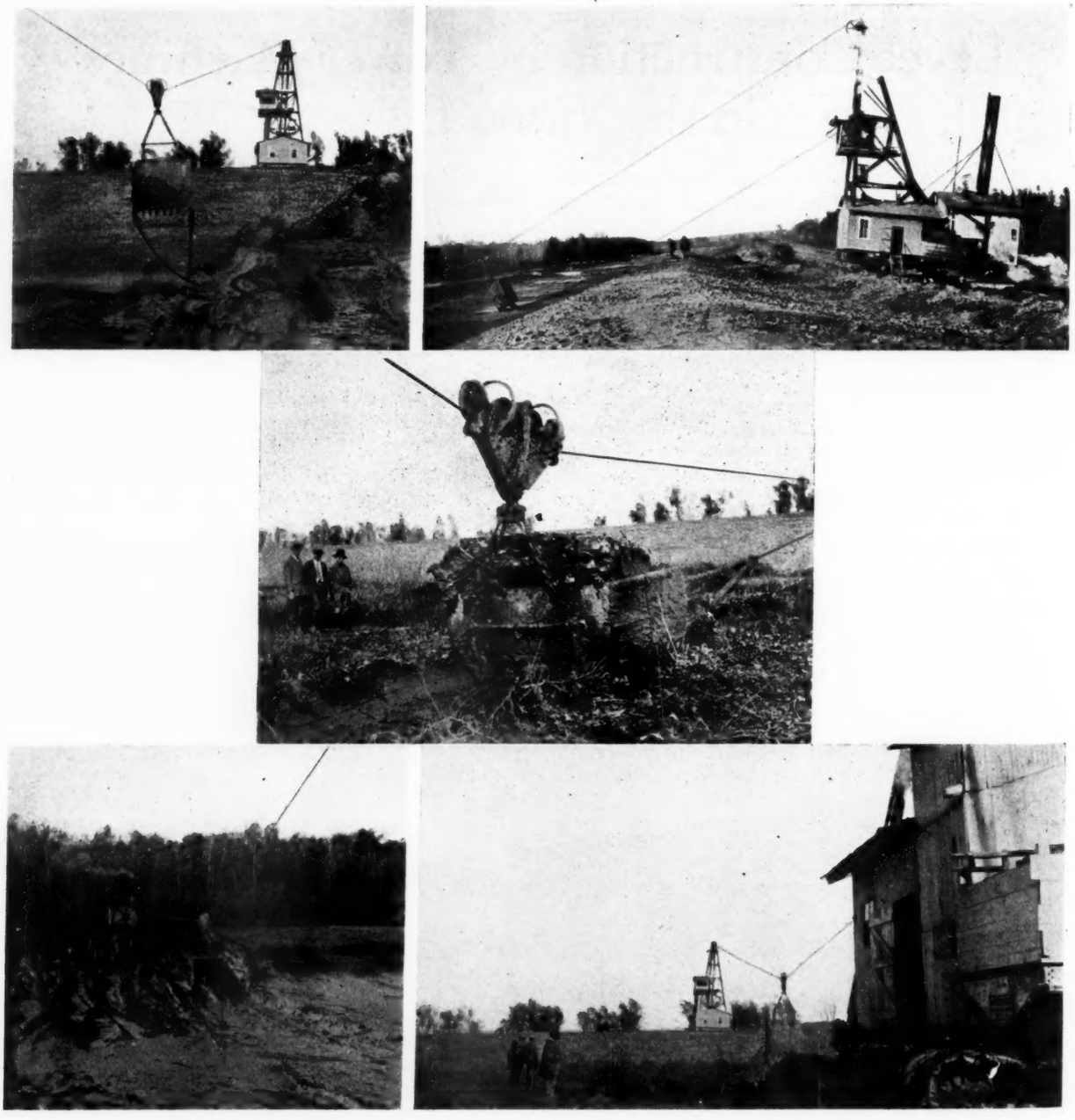
the levee section. The estimated cost on this is about 16 cents per yard.

Wagons and Draglines Cooperate

Across the river, and not far from this job, Sternberg and Co. have a contract on which the work is being done by a combination of wagons and large draglines, each putting up that part of the levee for which it is best suited under the conditions prevailing. As occurs in constructing many of the present-day levees, not enough dirt for construction is available within economical reach of the larger machines. In this case, the landside section of the levee, totalling from 40 to 50% of the yardage, is being built up with crawler wagons, while draglines handle the remainder of the dirt.

On this job are four Caterpillar tractors, four Crawler wagons, and a Linn tractor. These are loaded by a P. & H. 1¼-yard diesel-powered dragline. This equipment constructs the base section as shown in Fig. 3. On this work, the diesel-powered machine has proven very economical, operating for a full 20-hour day on a fuel cost of approximately $3.

This hauling equipment leaves the close dirt—that is, the dirt within two or three hundred feet of the river side of the levee. This dirt is handled, and the levee section completed, by two Monighan draglines. A large machine, with a 110-foot boom and 4½-yard bucket, works on the berm, while a 2½-yard, 85-foot boom machine, throws in, finishes, and does such other work as may be necessary.



BUILDING LEVEE WITH TOWER MACHINE WITH 600-FOOT REACH

In the center picture is shown the six-yard bucket. At the top, two views of the levee end, and at the bottom of the other end, of the cable.

Essentials of Engineering Contracts

Lump sum, unit price and cost-plus contracts. What should be included in invitation to bid, contract, bond, proposals and specifications. Retained percentage, extra work, liquidated damages, arbitration.

By James H. Griffin

Engineer in Charge, Bureau of Contracts and Specifications, Board of Transportation, City of New York.

ENGINEERING contracts, as the term is used in this discussion, are agreements formed by the acts of parties whereby some legal obligation is assumed in relation to an engineering project.

There should be but little difference between so-called public and private contracts, except that the public contract is limited by the various authorities and legislative acts designed to prevent abuse of power or the exercise of favoritism growing out of abuses practiced in days gone by.

Aim of Contracts.—A contract should first of all be fair to both parties. This is not only for economy and soundness of construction, but a one-sided contract is likely to fare badly in case it is litigated and the courts are called upon to pass judgment. Unfairness may be due not only to arbitrary clauses; but frequently to failure to furnish the contractor with full and complete information on which he may base his bid. However, either party may be unscrupulous and ready to take advantage of any weakness; the contractor is naturally in business to make money; the owner is usually determined to have the best job done for the least cost. Pure altruism is a virtue rarely encountered in these days of keen competition. The contract should always be drafted with these facts in view.

Contracts for Whole Work.—Wherever possible, one contract should be let for the whole work rather than several contracts, each covering a portion of the work. With one contractor responsible, it is easier for the engineer to supervise the work and often more economical. Usually difficulties arise where the work of several contractors overlaps, with resulting delays and possible claims against the owner. Even where the work is so diversified that one contractor cannot perform all of it with his own forces, it frequently is better for the owner that the work be done under subcontracts where the owner can hold the general contractor responsible.

Lump Sum.—The most common bases of payment to a contractor for work done under an engineering contract are lump sum, unit price, and cost plus. These determine largely the set-up or type of the contract.

The lump sum type is applicable to work where the units can be accurately estimated in advance, as in work above ground. It has no flexibility and in case changes in plans occur, as they inevitably do, adjustment of price must be made, which must be arbitrated or else the owner is more or less at the mercy of the contractor. It is therefore advisable, under the lump sum contract, to agree in advance upon unit prices for each kind of work to be done, these prices to be allowed or paid for any changes in the original plans.

A modified lump sum contract, in which the contractor guarantees the cost not to exceed a fixed sum, which he gives in his bid, is written quite often. This guaranteed cost may include the contractor's fee or the fee may be bid separately. Should the total cost of completing the work be less than the guaranteed cost, the contractor and the owner share in the difference. This gives a little flexibility to the contract and permits a revision of plans for economy without the necessity of bargaining for a rebate. In such a contract it is advisable to enumerate in the contract the items which are chargeable to the cost of the work.

Unit Price.—The unit price contract is applicable where the various items of work are not definitely known and therefore cannot be accurately estimated, as in work below ground. It has the advantage of a certain amount of flexibility, but the disadvantage that it admits of juggling of the prices and costs of the various items of work when bids are prepared. Since the quantities of the various units of work are admittedly subject to increase or decrease, a bidder is tempted to unbalance and bid high on the items which he may gamble will be increased and low on the items which he may gamble will be decreased. The aggregate total, upon which the bids are compared, may not be materially affected.

There is a further temptation to unbalance by overloading items which are paid for early in the job, to assist a financially weak contractor to finance his work. Unbalancing of items, however, works to the disadvantage of the owner and sometimes also to the disadvantage of the contractor. It invariably works a hardship on one of the parties in case of annulment of the contract. No condemnation of bidding methods or of contractors is intended by these statements. There is simply a door left wide open in the unit price contract.

It is quite possible to compute the direct cost of labor and material for any item of work, but it is quite impossible to distribute a fixed overhead charge over variable items. Most contractors will therefore distribute their overhead charges over those certain items which they gamble will increase, or at least not be decreased. A gamble is thus introduced which it is desirable to avoid if possible.

The problem of distributing overhead and profit in unit price contracts may be partially if not entirely solved, and therefore the temptation to unbalance at least partially removed, by inviting a separate bid on overhead and profit, which might also include compensation for certain plant. This bid would be expressed in percentage of the aggregate bid and applied to the partial as well as final estimates, assuming an even distribution of overhead and profit in proportion to work done. Thus the imprudent bidder,

instead of finding himself operating at bare cost or possibly at a loss during the later stages of the job, would be assured of a return sufficient not only to meet his payroll but also his rent, insurance premiums, salaries and other items which must be paid until completion of the work.

In the unit price contract it is essential to enumerate the items of cost included in each item bid as well as to prescribe accurately the lines of measurement of each item. This is sometimes difficult, as some items shade into other items, and it is hard to define the line of demarcation. There is an opening for a claim where any item is not fully described. Some contracts leave a great deal for the engineer's decision. This should be avoided wherever possible. It leads often to controversy and may even lead to charges of unfairness on the part of the engineer, no matter how scrupulous he may have been.

Cost-Plus.—The third type of engineering contract of which many engineers disapprove but which has been used quite extensively, is the so-called "cost-plus" contract. Its proponents claim that it avoids many of the objections to the lump sum and unit price contracts; that it removes some of the responsibility placed upon the contractor for which the owner pays dearly; that it permits of changes in plan without adjustment of prices; that it eliminates bills for extras and vexatious claims.

The simple "cost-plus-percentage" contract is open to the general objection that it removes incentive for efficient work, since the greater the cost the greater will be the percentage profit. It also offers the unscrupulous contractor an opportunity to "skin" the owner by padding the material bills. Unless there is an effective check on it, the unscrupulous contractor may be tempted to put fifty men to work at a job which could be done more efficiently and satisfactorily with twenty-five. The workmen also soon appreciate the fact that their employer is not interested in efficient work. The cost-plus contract, however, may provide the incentive for efficiency with a sliding percentage to the contractor which could be so arranged as to give a larger fee for a smaller cost.

The cost-plus contract is applicable to emergency situations. A railroad bridge may have been washed away by a freshet; repair must be made at once; the cost of the work is a secondary consideration. The country may be at war. The situation may demand that work be started even before a contract can be delivered. Contractors must be selected from among those with the greatest capacity and highest reputation. Labor and material markets are fluctuating. Conditions, specifications and requirements are changing from day to day. Results are paramount. In these situations the cost-plus contract meets the demand as no other type of contract could.

Contract Documents

The contract documents usually consist of the invitation to bid, information to bidders (which may be separate documents or combined), the form of contract, bond, proposal and specifications. These, with the contract drawings, constitute the complete engineering contract when properly executed by parties and sureties and then delivered. These documents may be bound under one cover or separately issued. Some attorneys prefer that all documents be bound together when issued and that they be executed by the parties on the last page so as to embrace all that has been set forth. Frequently the specifications and drawings are issued under separate cover. A form of contract for builders can be purchased in any good stationery store. There are a number of good uniform contract forms which have been developed by various agencies such as the American Railway Engineering Association and the American Institute of Architects.

Invitation to Bid.—The invitation to bid should be given wide publicity so as to insure the widest competition. In some situations a complete list of items of work are given with the invitation. This does not seem to be good practice, as it might induce a contractor to make up a bid without a thorough reading of the form of contract and specifications, which is essential. It appears to be desirable, from a legal standpoint, to give a complete schedule of prices in the form of contract, in addition to that given in the proposal, on the theory that the form should include a specific provision setting up the price or prices which the owner agrees to pay and the contractor agrees to accept for the work.

Information for Bidders.—The information for bidders, if given separately, should be confined to a statement of what the bidder is required to give in the way of security, explanation of what details are required in submitting the proposal and similar information. In cases where the contractor is required to have special experience and large financial resources, it is found advantageous to specify what will be demanded in this connection, so as to warn off contractors which would be unable to qualify. The right to reject any and all bids should always be reserved.

Changes.—The contract may be altered by mutual consent of the parties. The sureties or bondsmen must also consent or be released from obligation. The right of the owner to make changes in plans should always be reserved. If this right is reserved, the contractor and the sureties will be held so long as the changes reasonably modify the contract and do not so alter the general character of the work as to virtually substitute a new contract. In a lump sum contract it is advisable to agree in advance, by specific provision, upon the allowances or payments to be made for various items of work affected by changes.

Retained Percentage.—It is common practice to retain a percentage of the estimates as additional security. The percentages retained vary widely. In an analysis of contracts in five hundred cities, the percentage was found to vary from one to forty per cent. Fifteen per cent was most common in contracts for public work. In contracts for subway construction in New York City, a sliding scale is used under which fifteen per cent is retained from the partial estimates until an amount equal to ten per cent of the total bid has been retained; thereafter the retained amount is reduced by returning fifteen per cent to the contractor with each estimate until five per cent of the total cost is finally withheld. By this method the maximum amount is withheld at the most critical time, when the work is about two-thirds completed.

Extra Work.—A provision for extra work is very important in the unit price contracts. Payment is usually on a cost-plus basis and is therefore open to the objections previously cited in connection with the cost-plus type contract. Extra work should be ordered

(Continued on page 74)

Economics of Highway Design*

Conclusion of article begun in preceding issue which summarizes latest data on this topic. Soil classification and subgrade analysis. Types of surfacing.

By A. G. Bruce

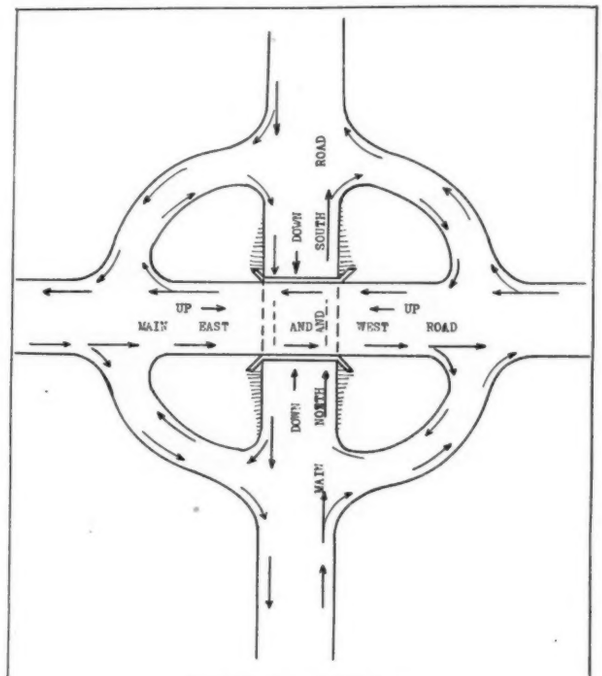
Senior Highway Engineer, Bureau of Public Roads

Soil Classification and Subgrade Analysis

BEFORE the type of surfacing is selected, a study of the soil characteristics should be made to determine what influence the subgrade will probably exert upon the pavement. In the laboratory the subgrade is classified according to its clay, silt and sand content and its physical characteristics. Material possessing capillarity and cohesion, and generally consisting of particles not larger than .005 millimeter in diameter, is defined as clay. Material possessing capillarity in appreciable amount, and little or no cohesion, and consisting of particles not larger than .05 millimeter nor smaller than .005 millimeter in diameter, is defined as silt. Material possessing neither capillarity nor cohesion in appreciable amounts, and consisting of particles larger than .05 millimeter, is defined as sand. The laboratory analysis of the soil determines the per cent of clay, of silt, and of sand, lower liquid limit, shrinkage ratio, moisture equivalent and volume change.

The study of soil characteristics has not progressed sufficiently to permit permanent classification, but as a tentative classification, subgrade soils have been graded by Mr. Hogentogler of the Bureau of Public Roads as follows:

*A lecture delivered before the Highway and Railway Division of the Civil Engineering Session of the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education at Yale University, July 18, 1930.



HIGHWAY GRADE SEPARATION DESIGN
(No left hand turns or crossing of traffic)
ALL RIGHT HAND TURNS MADE TO THE RIGHT BEFORE THE INTERSECTION IS REACHED. ALL LEFT HAND TURNS MADE TO THE RIGHT AFTER PASSING THE INTERSECTION.

Concrete road in North Carolina.

Group A-1.—Well graded material, coarse and fine, excellent binder. Highly stable under wheel loads, irrespective of moisture conditions. Functions satisfactorily when surface-treated or when used as a base for relatively thin wearing courses. Represented by the excellent topsoils of Georgia.

Group A-2.—Coarse and fine materials, inferior binder. Highly stable when fairly dry. Apt to soften at high water content caused either by rains or by capillary rise from saturated lower strata when an impervious cover prevents evaporation from the top layer.

Group A-3.—Coarse material only, no binder. Lacks stability under wheel loads, but unaffected by moisture conditions. Furnishes excellent support for flexible pavements of moderate thickness and for relatively thin rigid pavements. Represented by the Florida sands.

Group A-4.—Silt soils without coarse material, and with no appreciable amount of clay. Apt to absorb water very readily in quantities sufficient to cause rapid loss of stability even when not manipulated. When dry or damp, presents a firm riding surface which rebounds very little upon the removal of load. Apt to cause cracking in rigid pavements due to frost heaving, and failure in flexible pavements due to low support. Represented by the New Hampshire silts.

Group A-5.—Similar to Group A-4, but furnishes highly elastic riding surfaces with appreciable rebound upon removal of load, even when dry. Elastic properties interfere with proper compaction of macadams during construction and with retention of good bond afterwards. Represented by highly micaceous soils of North Carolina.

Group A-6.—Clay soils without coarse material. In stiff or soft plastic state absorb additional water only if manipulated. May then change to liquid state and work up into the interstices of macadams. Furnish firm support essential in properly compacting macadams only at stiff consistency. Deformations occur slowly and removal of load causes very little rebound. Shrinkage properties combined with alternate wetting and drying under field conditions are apt to cause cracking in rigid pavements. Represented by the Mississippi gumbo.

Group A-7.—Similar to Group A-6, but when moist deforms quickly under load and rebounds appreciably upon removal of load. Thus, lacks firmness in support, similar to subgrades of Group A-5. Alternate wetting and drying under field conditions leads to even more detrimental volume changes than in Group 6 subgrades. May cause concrete pavements to crack before setting and to crack and fault afterwards. Represented by Illinois gumbo and typical adobes.

Group 8.—Very soft peat and muck incapable of supporting a road surface without being previously compacted or displaced by a fill. Represented by Michigan peat bogs.

Subgrades which fall in group 1 are very stable and should make satisfactory roads even with thin wearing

courses. Subgrades in groups 2 and 3 may be used for non-rigid pavements of usual design, while well drained subgrades in groups 4, 5 and 6 may be satisfactory for non-rigid pavements if supported by thick sub-bases. Unless the group 4 to 7 sub-grades can be drained or otherwise stabilized, they should not ordinarily be used for non-rigid types of pavement. On these subgrades a pavement with beam strength is needed to so distribute the load that but a small intensity of pressure is exerted on the soil. The supporting power of the subgrades in groups 4 to 6 may be materially increased by the introduction of admixtures which provide additional cohesion and internal friction. These admixtures may be sand, gravel, clay, lime and asphaltic oils.

Rigid pavements distribute the load over a large area, and therefore do not need the firm support required for non-rigid pavements. The subgrade for rigid pavements may be soft, but so long as the support is uniform and does not change volume during the setting period, there should be no unusual failure. The non-rigid pavement, having little beam strength, transmits the load almost directly to the subgrade and, therefore, it must have firm subgrade support or failure is likely to result. In our tests at Arlington we have found that the pressure per square inch on a soft clay subgrade may be ten times as much through macadam as through concrete of the same slab depth. If the soil is soft and spongy there is very little chance of success with non-rigid pavement without deep subbases. A clay subgrade may be improved by an oil primer to keep the capillary water out of the macadam base course. To prevent lateral flow, the subgrade should be rolled beyond the edge of the pavement, and greater stability of top course will result if the base course is carried out a foot beyond the edge of the top course.

TYPES OF SURFACING

The various surfacing materials are usually grouped into three classes, namely, low-type, intermediate-type and high-type. There is, however, no clear line of demarcation between the classes, and with the development of surfaces by stage construction the low types merged with the intermediate types and the intermediate types with the high types. Those surfacings usually classed as low-type are sand-clay, top soil, disintegrated granite, gravel, slag, caliche, shell, cinders, soft lime rock and waterbound macadam untreated. The intermediate types are waterbound macadam surface treated; gravel, slag and sand-clay, surface treated or processed; sand asphalt and bituminous macadam. The high-type surfacings are bituminous concrete, natural rock asphalt, Portland cement concrete, brick and other block types.

Economy—In selecting the type of surfacing, consideration should be given to the motor vehicle operation costs, as well as to the maintenance costs and the fixed charges such as interest on the investment and depreciation. There is a noticeable lack of agreement as to the correct method of comparing road types, due to the fact that traffic conditions are changing so rapidly from year to year that dependable data on depreciation and maintenance are very difficult to obtain. Tests conducted in Iowa and Michigan indicate that vehicle operating costs are about one cent less per mile per year on intermediate-type surfacing than on low-type, and also about one cent less on high-type than on intermediate-type. If dependable maintenance data are available and if depreciation per year can be estimated with any certainty, then the most economical type to build is the one which gives the lowest annual cost per mile for interest, depreciation, maintenance and vehicle operating costs. The last charge would be the average cost of motor vehicle operation per car on the particular type of surfacing under consideration, multiplied by the total number of vehicles.

Generally speaking, the low-type surfacings are economical until the traffic is between 300 and 500 vehicles per day. Between 500 and 1500 the intermediate type is generally economical, and beyond 1500 the high type will usually prove the best investment. If truck traffic constitutes more than 10% of the whole, or if unusually heavy loads are carried, or if unusual soil and climatic conditions prevail, the above general conclusions may not hold good.

Low-Cost Roads

During the past two years there has been unusually keen interest in low-cost roads. Traffic studies have shown that a large part of the rural county and township roads carry very light traffic and on such roads high-type surfacings are usually not economically justified. There are in the United States about 3,000,000 miles of roads and at the present time only 660,000 miles are surfaced. Most of the unimproved and unsurfaced mileage is on the county and township road system and it is becoming apparent to all highway officials that any improvement of magnitude must be by means of low-cost types.

In planning the design of low-cost roads, a distinction should be made between those which will for many years carry very light traffic, and those which will need only low-cost surfacing for the present, but which will eventually need some more durable type. On the first group, standards of location, grade and alignment may be much inferior to those of the second group, for which the first stage of development must be wisely designed or it can not be used as a foundation for the successive stages of improvement.

Classified according to their method of construction, the usual low-cost type surfacings fall into seven groups:

GROUP 1. Treatment of the natural subgrade. This includes calcium chloride applications and oil treatments.

GROUP 2. Untreated surfacing of sand-clay, slag, shell, gravel, and crushed stone. This includes the traffic-bound as well as the roller-bound construction.

GROUP 3. Bituminous surface treatments on the surfaces listed under group 2. This includes single, double and multiple surface treatments.

GROUP 4. Mixed-in-place bituminous treatments. This includes the fuel oil treatments, tar and emulsion treatments, and retread.

GROUP 5. Plant-mixed bituminous treatments. This includes both cold and hot mixed types. Also sand asphalt and natural rock asphalt.

GROUP 6. Bituminous macadam penetration.

GROUP 7. Single-lane hard pavements.

Gumbo Soils—One of the newest developments has been the treatment of clay and gumbo soils in Minnesota, North Dakota and Canada, with oil and thin gravel blotter. After the road has been graded and

(Continued on page 64)

THE EDITOR'S PAGE

Sewage Treatment in Japan

The first municipal sewage treatment plant to be built in Japan for actual service (there have been some experimental ones) is nearing completion and is described in this issue by a Japanese engineer. The article indicates a most ambitious plant for an initial one, including the most recent methods and devices used in the United States. The engineers and officials have indicated their confidence that the plant will operate successfully without the creation of odors, by locating it in the center of the city. It is presumed that the municipality later will do its part, with a full realization of the fact that avoidance of nuisance is as much a matter of operation as of design and construction.

We feel confident that this plant (there are really two plants serving separate parts of the city) will so satisfactorily meet expectations that other cities of Japan will speedily follow Nagoya's example in improving the sanitary condition of the city and the river on which it lies.

Snow Drift Prevention

Fifty years ago the idea of clearing roads, or even the streets of northern cities, of snow was not considered. To do so would spoil the sleighing. Instead, snow was shoveled onto bare spots where practicable. All traffic, even street cars, went on runners; and there were sleighs enough to accommodate it all. If drifts blocked the roads, the farmers stayed at home —even though there were no radios or even telephones or phonographs—and improved their minds reading Whittier's "Snowbound" or the "Farmers' Almanac."

Had they considered clearing the roads, it would have been impracticable with hand shovels and horse-drawn wooden V-plows as the only means. What a difference the last few years have made! Now rapid truck plows quickly remove snows less than 12 inches deep which have not been compacted by traffic or sun and rain, while deeper drifts yield to the heavier but slower tractor equipment.

But now engineers are taking another step. It is impossible to prevent snow falling—at present, at least; but it is not the fallen snow which gives the most trouble, but that blown into drifts. If drifts could be prevented, or if snow could be blown off the roads instead of onto them, much trouble and expense would be avoided. And this is possible on a considerable percentage of highway mileage. An analysis of the problem as it exists in open, rolling country is given in an article in this issue.

The author tells of the possibilities of designing and constructing roads with this in view. Roads raised even six inches above the general level of the snow will be kept clear by the wind, if there is any. Where the cost of snow removal, capitalized, equals or exceeds the cost of raising the road to such elevation, such construction is economically desirable. In some cases the road can be so located with reference to topography and prevailing winds as not to lie across the path of drifting snow.

Cuts present the most difficulty and are not always avoidable. Drifting snow collects in them, sometimes to great depths, and removal of it is difficult. One such cut may tie up the traffic on miles of an important highway until the drifting of snow nearly ceases, even though a plow run continuously back and forth through the cut. Here loss and inconvenience to traffic as well as cost of snow fighting should be considered as an offset to cost of eliminating such a cut, or of ameliorating the condition, as by flattening the slopes and providing wind-breaks. Or in some cases the direction of the cut can be changed so that prevailing winter winds will blow *through* it, blowing the snow out of the cut instead of into it.

Then there are preventive measures such as snow fences, wind breaks of trees, etc. Easement for retaining or planting trees on a strip along the windward side of a road at cuts can sometimes be obtained at little cost—certainly less than the capitalized annual cost of snow fighting and traffic delay some cuts entail. As stated on page 28, the North Dakota Highway Commission is asking farmers to postpone until spring the plowing or other removal of stubble, corn stalks, etc., for two hundred feet along the side of main roads to prevent or diminish drifts on the roads.

The idea of snow prevention is perhaps the latest among the considerations entering into road design, and highway engineers should give it the study its importance warrants.

Quantity Production in Road Paving

Theory in contracting is not all poppycock. The unmethodical contractor who may know how to get pick-and-shovel work out of his men but can not plan and coordinate the use of the latest labor-saving equipment can hope to compete successfully for only small jobs these days.

For two or three years the Bureau of Public Roads has been making a minute study of the operation of power shovels and concrete mixers, and more recently the Pennsylvania Highway Department has similarly studied concrete road construction; and both have come to the conclusion that most contractors on such work could increase the efficiency of their men and equipment twenty-five to fifty percent by better management. Pennsylvania engineers have set a standard for a mixer output as an asymtote for the efficiency curve, as described in our September issue. And this month we describe how one contractor secured more than 97 percent mixer efficiency as the average for a week; while for a month this gang averaged 172 square yards of 9-7-9 pavement an hour.
Q.E.D.

Two Activated Sludge Plants in Japan

Nearing completion at Nagoya to serve three hundred thousand population. The first full-size sewage treatment plants in Japan.

By Tsunejiroh Kawahara
Civil Engineer of Nagoya Municipality, Japan

THE status of progress of sewage treatment in Japan is now still moving at a snail's pace. Although some of the larger cities in Japan have an experimental plant on a small scale, it will be out of the question to compare with those in the Occident.

The two plants in Nagoya, now being under construction, are approaching completion within a year; they are the first full-size ones in this country.

The city of Nagoya is the third town in size in Japan, having 1,000,000 people; it is becoming one of the centers of communication between the East and West of Japan.

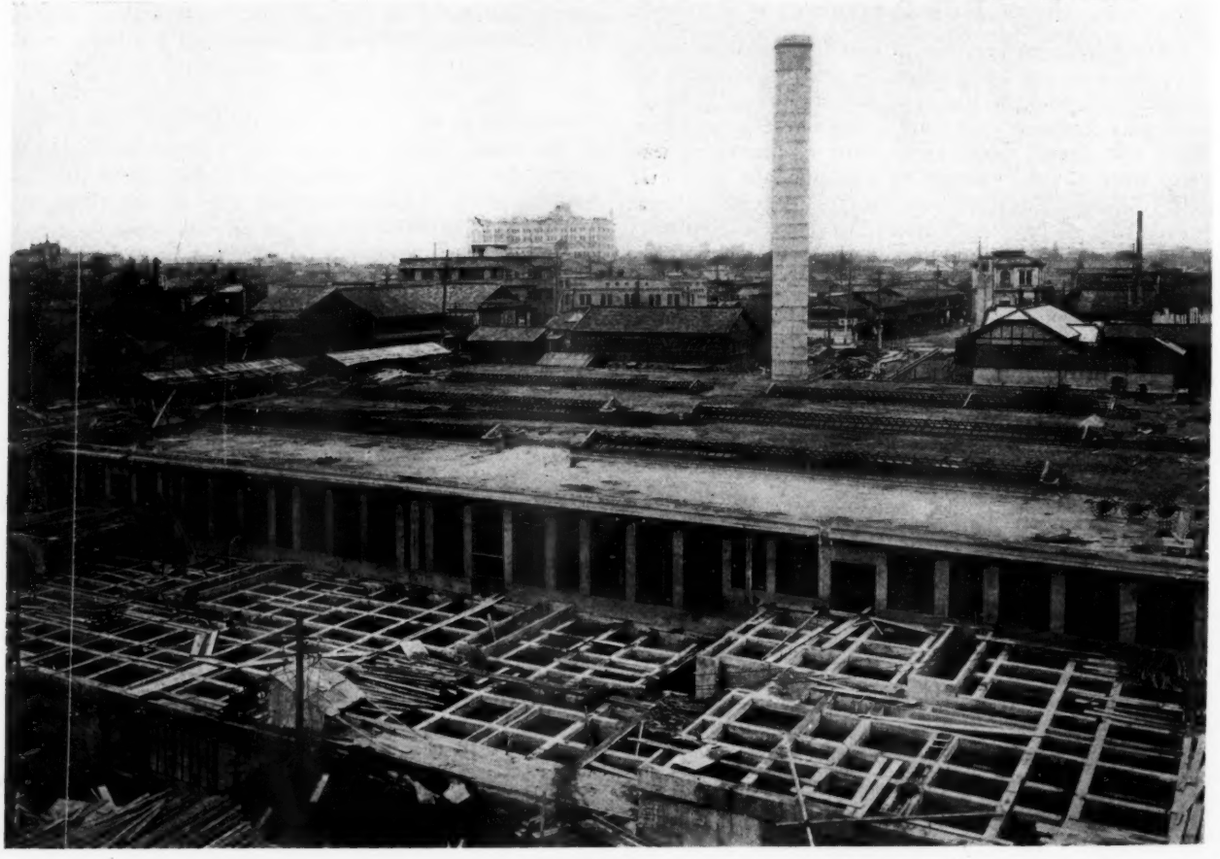
The sewage catchment area of this city has been divided into three major sewage-treatment districts according to its geographical condition.

The trunk sewers, in a combined sewage system, were laid out previously during the past decade. Their outfalls are situated in two canals entering the city longitudinally from the south to north. Although these canals are navigable, being polluted day by day at the present time, they are in an insanitary condition, containing black-colored water. The canal head (canal-bay), where two outfalls of two main trunk sewers are situated, was utilized as the site of a plant to dispose of sewage. The plant is called "Horidome" (means end of canal or canal-bay) plant, and is now under construction to operate within several months.

This plant is designed for 300,000 population, 11,200,000 gallons per day of dry-weather flow, and three times that quantity during wet weather. This plant has a site area of 2.5 acres, and is to deal with mainly domestic sewage from an area of 5.01 square miles, including the civic center zone of this city.

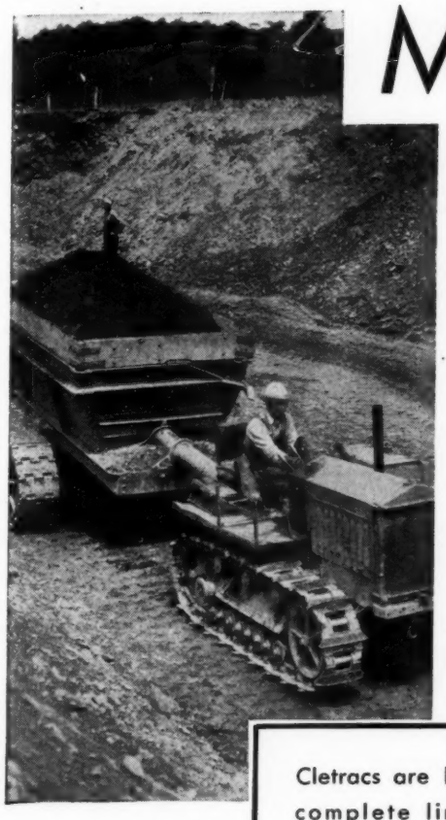
This plant has two grit chambers, each having two compartments; six preliminary settling tanks; two open conduits leading to the aeration tanks; eight aeration tank units (three courses of each tank have a total length of 468 ft., effective depth 15.5 ft. and 7.0 ft. wide); four reaeration tanks; six final settling tanks; and two sludge-storage tanks. Besides, there are a sewage chamber capable of holding one hour quantity of dry-weather flow; a pumping station, and a three-storied building with offices, laboratory and blower room.

Because this plant is located on low land at the canal-head in the center of a densely built-up district in the middle part of this city, the major part of this



View of Horidome plant under construction, March, 1930. Completed roof with skylights in background.

Cletrac Power Makes Jobs Move Faster, Cost Less



Let it Establish New Standards of Speed and Economy for You!

FASTER travel—more yardage to dirt loads — wider, deeper cuts with larger scrapers and scoops — these are direct short-cuts to money-saving and bigger-profit margins. Cletracs put these short-cuts into operation on every job.

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Cletracs are built in a complete line which covers practically the entire range of tractor power requirements in both industry and agriculture — a size to meet every power need of outdoor work.

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Lower photo shows Cletrac 80-60 owned and operated by Summit County, Ohio.

The *classified* INDUSTRIAL LITERATURE section is your guide to the latest catalogs—see page 93

Why An Owen Gets Bigger Bites

OWEN Bucket lips and teeth hit first when the open bucket drops, *no other part of the bucket touching the material.* Thus the total weight of the bucket is utilized to force the teeth and cutting edges of the jaws into the material. This feature also provides an advantage—not found in any other bucket—the use of the full open spread of the bucket before the closing power is applied.

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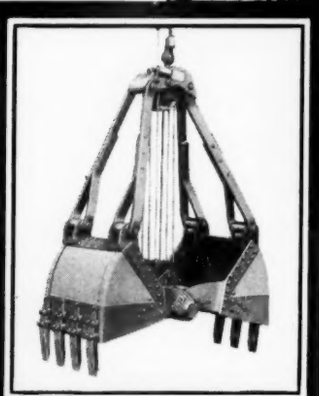

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1. One-piece steel cross-head.
2. No wear in upper or lower arm ends.
3. Heavy high carbon steel arms.
4. Adjustable undiminished closing power.
5. Long life to sheaves and cable.
6. Long arm bolt bearings sealed from grit.
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10. Cable clips eliminated.
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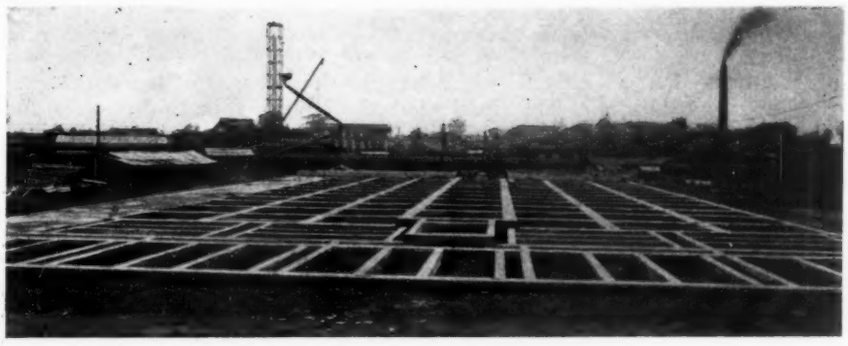
15. Rigid shell construction.
16. Heavy duty high carbon drop-forged steel teeth.
17. **Lips or teeth points hit first.**

OWEN CLAMSHELL BUCKETS INSURE BIGGER BITES

Owen Buckets

The *classified* INDUSTRIAL LITERATURE section is your guide to the latest catalogs—see page 93



View of Atsuta plant under construction.

installation is enclosed in a broad building with 15 ft. height to the ceiling, and the building has a chimney-like tower carried 100 ft. above the ground to ventilate and prevent (or minimize) bad odors in order to eliminate the complaints of the neighboring inhabitants. The roof of that building is on a level with the adjacent highway and garden lawns are planted except on the sky-light parts, and electric lighting posts stand the same as in a small park, so that one may enjoy the cool breezes on the warm summer evenings.

"Atsuta Plant," the other plant, has 2.4 acres as its site area, which allows for future extension, and was designed for 130,000 people, to handle domestic and factory sewage from an area of 2.07 square miles, including the factory zone of this city's southern parts. The capacity is 4,700,000 gal. per day of d.w.f. and three times this quantity in wet weather. It consists of a leading chamber; a sewage-storage chamber, two units of aeration tanks (effective depth 15.5 ft.; width 13.2 ft., with deflector at one side); a reaeration tank; eight final settling tanks, and a sludge-storage tank. An existing installation in the present pumping station is utilized for the grit chamber and settling tanks. The aeration period is five hours, at rating of 2 cu. ft. of air per gal. (or 15 times the quantity of sewage) with return sludge equivalent to 25 per cent of the quantity of raw sewage. The ratio of diffuser area to tank area is 1:12.

The excess sludge from the storage tanks in both the plants is filtered, part through Oliver filters at "Atsuta Plant," but the greater part is conveyed to the mouth of the river, near the sea-coast (four miles away) by pumping through "Hume pipe," where a sludge drying bed is located; for if the sludge were discharged onto the sea-shore, the complaints from laver planters (seaplant to be eaten) might occur. In this country sludge is not yet considered as a such convenient matter to utilize as fertilizer (artificial fertilizer is used ordinarily).

There is great difficulty in finding a suitable ground for dumping the sludge rather than treating it; therefore, in the near future, the gasification process will be adopted or planned.

Unsuccessful Bidders Paid for Bidding

The Memphis Chapter of the Associated General Contractors has adopted a fee system for bidders, the successful bidder to pay each of the unsuccessful ones a fee ranging from $10 on jobs under $2,000 to $600 on jobs of over $1,000,000, and in addition a small percentage to the association for conducting the system. Each bidder is of course supposed to add to what his bid otherwise would be a sum sufficient to pay the other bidders. (We do not know how he learns beforehand how many bidders there will be.) The secretary of the chapter is said to have collected about $15,000 in fees in a year's operation. Apparently adding in the fee has not placed members of the chapter at a disadvantage as compared to other bidders, for out of 68 projects of which the chapter has a record, 39 were awarded to firms bidding in the fee. On eight projects awarded to contractors outside the chapter and on which were some bidders who included the fee, it was found that the difference between the low bid and the lowest bid including the fee, was greater than the estimating fee. It is quite clear that in these cases the estimating fee was not responsible for losing the job.

Waterworks or Fire Engines for Small-Town Fire Protection

By Collins Wight

Consulting Engineer, Dayton, Ohio

EVERY community of any size needs fire protection. This may be secured with chemical engines; with pumping engines securing water from cisterns, wells or streams; or from a waterworks system. There is a place for each of these, and local conditions are usually a governing factor. Such local conditions should be studied carefully before a decision is reached.

The community fire protection idea has spread rapidly. Here the central village furnishes shelter for the fire engine, the operators and a fair share of the initial cost, while the remainder is secured from farmers who desire more protection for their property. This idea is based on the responsibility that a town has for the community which it serves. The justification must be based on the service and the costs that result.

A decided handicap is that there is rarely enough water to be of much service, even though the engine arrive promptly. The usual well is good for not more than 2 or 3 minutes of pumping. A cistern, 6 feet in diameter and 10 feet deep, if full, holds water enough for a fire stream for only eight minutes. Many villages which rely on engines or chemicals for fire protection have such cisterns located at various points throughout the town, but the amount of water thus available is so small that, unless applied at the very beginning of the fire, it will not be of much value. Where a "bucket brigade" is used for bringing water to the engine (where common soda frequently is mixed with it), about a hundred 10-quart buckets per minute are required to maintain a single fire stream, and this supply is seldom possible of attainment, or even of approximation.

Chemical tanks are of little value after a fire is well under way, generally being limited to cases where the apparatus arrives before the fire has spread. The smaller type of equipment, such as the Ford AA or Chevrolet truck, is well suited for such use, and may also be equipped to pump water. Such a combination is cheap and has considerable value. Or motorcycle equipment can be purchased, and this

has the advantage, in addition to an even lower cost, of possessing high speed and of requiring but a small crew, thus minimizing starting delays.

However, in all cases where fire protection is under consideration, very careful attention should be given to the relative costs and advantages of fire protection equipment and a water works system. Often the reduction in insurance rates secured by the construction of a water system will equal all charges on the system, whereas the reduction secured by fire protection equipment, without a water supply under pressure, may be very much less.

The author is familiar with one town which sunk a 10-inch well and purchased two large fire engines. The cost of this work and equipment was $17,500. The estimated cost of a water system was only $27,500. The engine equipment gave the community an insurance classification of 9th, while the water system would have reduced the classification to 8th. The saving resulting from the better classification would have been as follows:

Type Buildings	When changing from no protection to chemicals, 10th to 9th	When changing from no protection to water works, 10th to 8th
Brick Mercantile Bldgs.	6%	28%
Contents	2%	4%
Frame Mercantile Bldgs.	3%	16%
Contents	3%	11%
Dwellings	7%	42%
Contents	7%	21%

These greater reductions come with standpipe or elevated tank service and with a fire hydrant in every block, which allows several lines of hose to be connected just as soon as the men and hose arrive.

The Inspection Bureau, which sets the fire rates that all smaller towns and villages pay, maintains a competent engineering department. A community, before spending money, should check with this Bureau the various reductions that may result from the installation of fire engines on the one hand and the construction of a waterworks system on the other. In that way it can be definitely known that the money is being spent to best advantage.

Dropping a Dam into Place

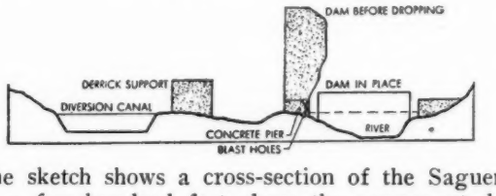
A reinforced concrete dam 92 feet long and 45 feet high is built on shore as a monolith and dropped into place in a river channel

"ACHIEVEMENT of a large enterprise is sometimes staked on an operation for which there can be no preliminary trials," says William S. Lee, president of the American Institute of Electrical Engineers, in his introduction to a description of engineering adventure in a "Research Narrative" of Engineering Foundation. The story would hardly be credited if not vouched for by such unquestioned authority. It is as follows:

"The Alcoa Power Co., Limited, a subsidiary of the Aluminum Company of America, has under construction a large hydro-electric power development at Chute-a-Caron on the Saguenay river about 140 miles north of the city of Quebec. The Saguenay river has a flow varying from 35,000 to 225,000 cubic feet per second. The site selected for the Chute-a-Caron power plant was naturally in a gorge located in a rocky section of the river. In order to complete the large masonry dam across this gorge it was necessary to excavate a diverting canal and turn the river at a time of low flow through this new channel while masonry foundations were extended across the original channel which was the deepest part of the gorge.

The usual method of putting in timber cribs and weighting them down with stones, or large blocks of any heavy substance, was not quite practical due to the extreme depth and high velocity of this water. James W. Rickey, hyraulic engineer of the Aluminum Company of America, suggested that a large, heavy, reinforced-concrete tower, or "obelisk," of the proper length, curved on one side so as to fit as nearly as possible the bottom of the river, be built on a concrete pier at the edge of the river, at a convenient place upstream from the proposed power dam; then, by blasting away a small portion of the pier, tip the obelisk over into the river so that it would become a dam. This scheme was worked out very carefully by Mr. Rickey's staff, also his consulting engineering staff, and his construction engineers on the ground.

The channel was excavated, and tunnels were built in the permanent dam with large gates capable of carrying 40,000 to 50,000 cubic feet of water per second and passing it through the powerhouse where the first hydraulic turbine was to be installed. Extensive preparations were required. Not only did Mr. Rickey have designs and computations thoroughly checked by his own staff and consulting staffs, but he had models made and moving pictures taken of the tipping of this diverting dam. By the means of a slow motion picture, it was thoroughly studied by all. So carefully was the whole scheme worked out that when this block of masonry 92 feet high, 45 feet wide and approximately 45 feet in the other dimension, containing 5,500 cubic yards of concrete, was dropped into the river, it landed almost perfectly in the place in which it was computed to land.



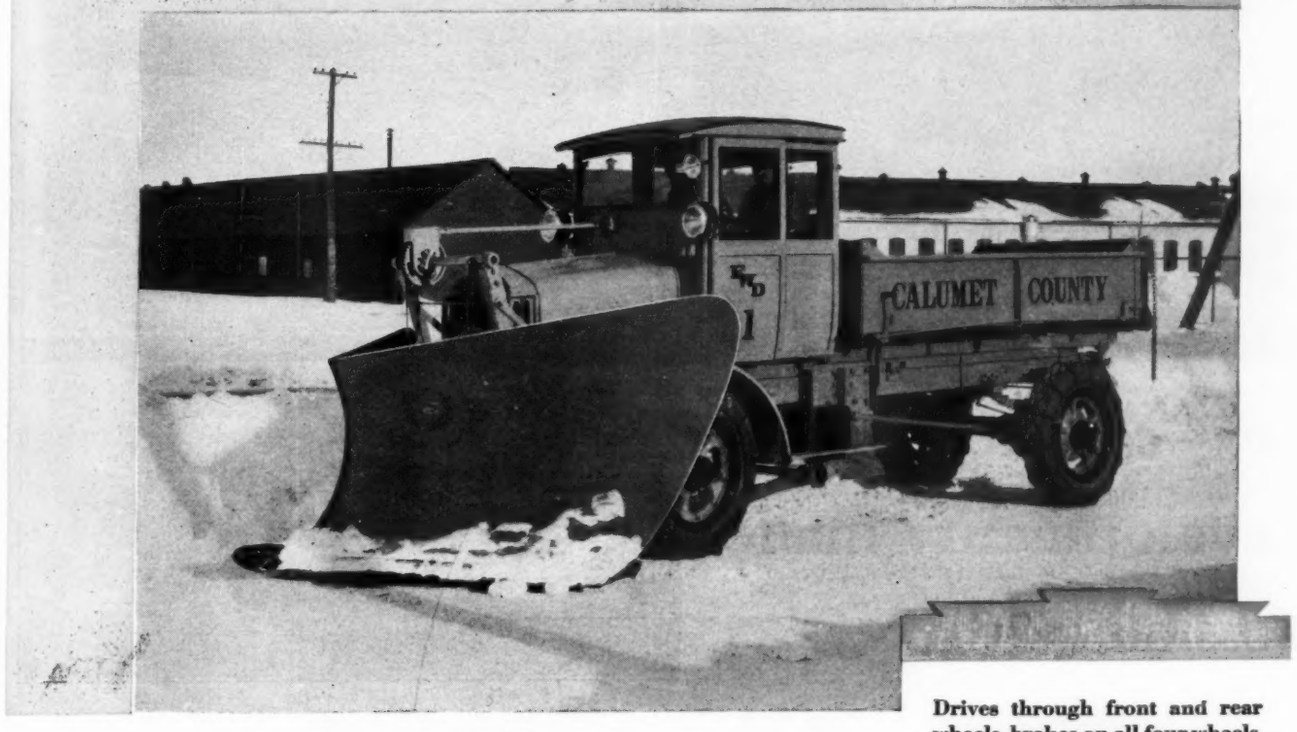
The sketch shows a cross-section of the Saguenay river a few hundred feet above the permanent dam, and the relative positions of the diversion channel and the permanent channel. The permanent channel was to be stopped by dropping the obelisk into it. The obelisk was built several months beforehand on the top of a pier composed of two parts. The right-hand part was arranged so it could be shot off by a large charge of dynamite, thus leaving the obelisk unsupported on the river side.

It was necessary to leave considerable water flowing down the old channel in order to form a cushion for the obelisk to fall into and thereby prevent breaking it. The quantity of water was regulated and this precaution worked perfectly.

On the day when everything was in readiness for dropping the obelisk, the holes in the front part of the pier were loaded with dynamite and it was blown away. When the large mass of the obelisk fell into the water, water was thrown 200 to 400 feet in all directions, but the obelisk being of such great weight and moving at such high velocity, even the swift current in the river did not affect it and it settled into place as it was expected to do, thus becoming the dam.

The entire scheme was a bold one but was carried through successfully and accomplished complete, satisfactory cofferdamming of a most dangerous and difficult stream of great volume and swiftness of flow.

It Won't be Long Now...



the Fight Will be On!

THE annual battle with Old Man Winter will begin again as usual in the latter part of the year. He will be in excellent condition. The bout starts with the first snow fall and lasts until spring.

Here is the way some of the state highway departments are going to meet him: California will use 17 FWD trucks; Idaho will use 20; Maryland, 66; Wyoming, 24 new FWDs; Nebraska, 10; Massachusetts, 102; Iowa, 170; Colorado, 8; Ohio, 18; Oregon, 50; Montana, 30; and the state of Minnesota will use approximately 200 trucks in its snow removal program, of which 48 will be FWD trucks. Altogether, 34 state highway departments and 5 provinces of Canada have purchased FWD trucks for road building, road maintenance and snow removal.

In snow removal the FWD holds to the road and goes straight ahead into the snow; there is no swerving or lifting of the front end of the truck. It does a straight clean job the first time through; there is no need to go back over the road again to "straighten it out". Whether the truck is being used to break the first opening through the snow or whether it is being used to move back a heavy bank; whether the impact of the snow is head-on or whether it is concentrated on one side of the plow, the FWD holds its ground the full length of the run. And it steers as easily as a touring car. That's a fact.

Write today for folder showing many different kinds of plows mounted on FWD trucks.

THE FOUR WHEEL DRIVE AUTO COMPANY, Clintonville, Wisconsin
CANADIAN FACTORY — KITCHENER, ONTARIO

Drives through front and rear wheels, brakes on all four wheels.

• •

Steers as easily as a pleasure car.

• •

A general service truck which adapts itself to special needs and provides more than economical transportation.

• •

Furnished in 2 to 10 ton sizes, including four wheel, six wheel and tractor trucks.

• •

Manufactured by the oldest and largest manufacturer of four wheel drive trucks in the world.

• •

Have increased in sales 1084% in the past eight years.

• •

Received 62% of 1929 orders from owners of FWD Trucks.

BACKED BY NATION WIDE SERVICE

FWD TRUCKS

The *classified* INDUSTRIAL LITERATURE section is your guide to the latest catalogs—see page 93

Low cost real estate development made possible with . . . .

GENUINE OPEN HEARTH IRON
GOHI
TRADE MARK
PURE IRON - COPPER ALLOY
REG U.S. PAT. OFF.

(Meet copper-bearing pure iron requirements in all accepted specifications for corrugated metal culverts.)

Corrugated Culverts

GOHI Culverts are easy to handle and quick to install. No doubt about it. The three men shown placed 300 feet of 72-inch diameter culvert in 10 hours' time — 30 feet an hour.

The installation was a large real estate development. Time was a vital factor. Less than two hours after the culvert men got on the job, it was possible to begin back filling.

No lost motion. No idle equipment. No days of delay and waiting between the start and finish of the culvert installation.

Rapid, low cost installation . . . strength to withstand the weight of the heaviest tractor . . . flexibility to prevent breakage under the pressure of freezing water and settling earth fills . . . these are some of the advantages of GOHI Culverts — reasons why you should use GOHI for all highway drainage, and other culvert installations.

Made of Genuine Open Hearth Iron — pure iron-copper alloy — GOHI Culverts offer maximum resistance to corrosion . . . no one yet knows for how many years.

Get all the facts. You'll specify and insist on GOHI Corrugated Culverts for every drainage job.

Use GOHI Culverts for

Highway Drainage
Airports
Storm Sewers
Railway Roadbed Drainage
Real Estate Developments
Golf Courses
Drainage of reclamation areas
Temporary or permanent Flumes.
Reservoir Syphons and Outlets

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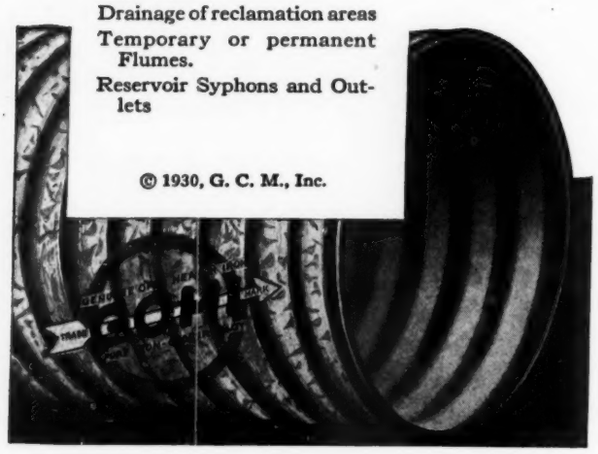

GOHI CULVERT MANUFACTURERS, Inc.
Newport, Ky.

Lincoln Steel and Forge Co.
St. Louis, Mo.

The Newport Culvert Co.
Newport, Ky.

The Pennsylvania Culvert Co.
Philadelphia, Pa.

Denver Steel & Iron Works Co.
Denver, Colo.

A. N. Eaton, Metal Products
Omaha, Nebr.

Feenaughty Machinery Co.
Portland, Oregon

Tennison Brothers
Texarkana, Ark.

Capital City Culvert Co.
Madison, Wis.

Central Culvert Co.
Ottumwa, Iowa

Roanoke Sales Corp.
Roanoke, Va.

St. Paul Corrugating Co.
St. Paul, Minn.

Tennison Brothers
Oklahoma City, Okla.

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Welding Cast-Iron Water Mains

Used for joints in an eight-inch line laid across a bridge, with expansion joints at ninety-six-foot intervals. Also used on thirty-six-foot line jacked through railroad embankment. Welding procedure.

WELDING is most common in connection with steel and wrought iron, but bronze-welding of cast iron is perfectly practicable and its use is increasing. In connection with a description of two instances, "Oxy-Acetylene Tips" says: "Bronze-welded joints of the improved shear-vee type, made under procedure control, will guarantee against leakage of the piping or joint maintenance expense in the future."

One of the instances referred to was that of a city which wished to lay a pipe across a river to supply a small town on the other side, laying 8-inch cast-iron pipe on a traffic bridge and covering the same with insulating material. This necessitated tight joints, to prevent leakage into the insulating material, in spite of vibration of the bridge.

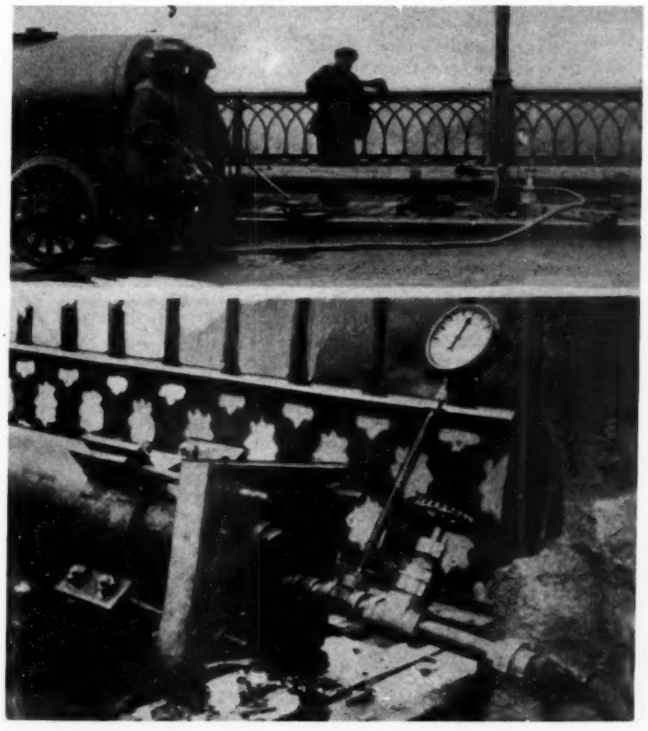
The pipe was obtained from the foundry in 32-foot lengths made by welding two 16-foot lengths together. These were unloaded from the car to a truck and trailer unit, which carried them to the bridge. Here they were unloaded onto wooden supports, three for each 32-foot length, and three of these lengths aligned and welded together. Each 96-foot section was tested under a hydrostatic pressure of 150 to 200 pounds per square inch, the ends of the pipe capped, the pipe filled with water from a small tank wagon, and the pressure applied by means of a small hand pump. None of the sections showed any leakage whatever. The 96-foot sections were joined by expansion joints and such a joint was placed near each of the expansion joints of the bridge.

The other case was one where a Missouri public utility company had to carry a 36-inch line of cast-iron pipe under a railroad right of way 150 feet wide, and was required to tunnel under the tracks, and also to secure joints perfectly safe against leakage. It was decided to bronze-weld the pipe and jack it under the tracks. It had already been obtained with plain ends, and the proper shear vee bevel was prepared by means of a grinder. The pipe was lined up and each joint tack welded at six points before the weld was made. During the welding, the weld section and the ends of the pipe were covered to retain sufficient heat in the pipe to avoid any possibility of local contraction, and after each joint had been completed the pipe was covered and allowed to cool slowly. The earth was dug out ahead of the pipe by hand, and the pipe jacked ahead a little at a time.

A description of the welding technique and organization is given, from which we quote the points of most interest to the water works engineer, omitting the details of the welding procedure itself.

"The check of the welders, the selection and inspection of material, the design and layout of the joints and the preparation for welding are all of vital importance in obtaining successful bronze welds in cast-iron pipe."

"*Welding Construction.* It is recommended that



Above—Filling pipe for test. Below—Cap for making test

Welding 8-inch cast iron pipe

the maximum number of sections of cast-iron pipe to be welded be six or eight, or from 72 to 96 feet of pipe. Expansion joints, or one of the various types of flexible pipe joints, should be used to join these longer sections.

"(a) *Welding Organization.* The welding and construction organization will vary somewhat according to the length and location of the line, the time limit for completion, street traffic and other factors.

"It is recommended that the pipe be purchased from the manufacturer with two, or possibly three, lengths bronze-welded together at the foundry. Only two or three welds are then required to joint a 96-ft. section and the welding personnel is held to a minimum. One welder, with a couple of helpers for aligning the 24-ft. sections, can join 400 to 700 ft of 6-in. pipe in a day, sufficient to keep up with a ditcher and ordinary laying crew. With larger pipe, the construction will, of course, be slower than with the smaller sizes of pipe.

"If the pipe is not supplied in double lengths, and the time is sufficient to warrant a detail organization, it is recommended that two lengths be bronze-welded together at the unloading point, or other convenient location, prior to stringing the sections of pipe along the right-of-way.

"(b) *Aligning.* The pipe having been strung, the sections should be lined up for welding in accordance with the correct aligning procedure. If the trench has been opened, alignment should be made over it on skids.

"(c) *Tacking and Welding.* One welder and one helper should be assigned to and be responsible for welding together a unit of from six to eight lengths (72 to 96 ft.) over the ditch.

"Two previously welded sections of two or more lengths each, welded either by the manufacturer or at point of delivery, should be aligned, tacked and welded together, the pipe being rotated by the helper so that welding may be performed on the upper surface of the pipe. The sections so welded together should then be joined by tacking and welding to form a six- or eight-length welded section as the requirement of the proposed line shall have determined.

"If the supply of oxygen and acetylene is located approximately mid-length of the six- to eight-length section and 50 ft. of hose provided for conveying each gas to the blowpipe, loss of time in shifting the supply will be avoided."

"Bronze melts at about 1650 deg. F. but at about 500 deg. F. its strength is only about one-half that at ordinary temperatures and strength diminishes rapidly with further temperature rise. High temperatures are, therefore, not necessary to permit sufficient yielding to relieve stress. For similar reasons, the joint should not be subjected to severe stress until well cooled.

Slow cooling is advantageous in this as in most welding processes, and a sheet of asbestos paper laid or loosely clamped around the completed joint will reduce the cooling rate. In stormy weather, the joint should be properly protected before welding and afterward until cool."

Well Supplies Prevalent in the Southwest

According to Wynkoop Kiersted, many western cities have developed well supplies, even when surface supplies or springs were available, because of difficulty and cost of rendering the latter safe by purification. In Colorado, 41% of the municipal supplies are obtained from wells. In the States of New Mexico, Arizona, Texas, Oklahoma, Arkansas, Kansas and Missouri from 65 to 78% of the total number of public supplies in use are well supplies.

Rental of Highway Machinery

AS in several other states, the counties of Wisconsin rent from the state highway department machinery for maintaining its highways. In Wisconsin a regular rental schedule is agreed upon, the rental charges being charged against the highway maintenance fund allotted to the county. The rental basis in the case of one county (probably similar to the charges made to the other counties) were as follows:

For the necessary tools and machinery, including planer, patrol grader, plow, slip scraper, and all small tools necessary for the maintenance for each patrol section. $9.00 per mo.

Tractor—
- 8-14 horsepower (Fordson) ..... .70 per hr.
- 15-24 horsepower (Lauson 2-ton Caterpillar)..1.00 per hr.
- 20-30 horsepower (Topp Stewart).....1.25 per hr.
- 25-29 horsepower (5-ton Caterpillar) .....1.50 per hr.
- 40-50 horsepower (10 and 15 ton Caterpillar)..3.00 per hr.

Power Graders—
- 8-14 horsepower with 8 and 10 ft. blades.... .90 per hr.
- 10-20 horsepower with 8 and 10 ft. blades.... .90 per hr.
- 10-20 horsepower with 12 ft. blade.....1.00 per hr.

Motor Trucks—
- Ford 1-ton and less..... .70 per hr.
- 1-Ton and less than 2-Tons .....1.05 per hr.
- 2-Ton and less than 3-Tons .....1.45 per hr.
- 3-Ton and less than 4-Tons .....1.75 per hr.
- 4-Ton and less than 5-Tons .....1.95 per hr.
- 5-Ton and over .....2.15 per hr.
- Ford truck as service car .....4.00 per day
- Patrol Supt. car ..... .08 per mi.

Road Graders—(Not included in patrol section equipment.)
- 5 ft. blade, 2 and 4 horse ..... .25 per day
- 8 ft. blade, 2 and 4 horse ..... .30 per day

Heavy Graders—
- 10 ft. blade, motor drawn ..... .40 per hr.
- 12 ft. blade, motor drawn ..... .50 per hr.
- Blade attachment for motor truck .....10.00 per mo.

Mowers— ... ...
- All classes ..... .50 per hr.

Gravel and Crushed Stone Producing Plants—
- Gravel plants complete ..... .30 per cy.
- Crushed stone plants complete ..... .50 per cy.

Road Rollers—
- 8-10 ton .....1.25 per hr.
- 2-5 ton ..... .75 per hr.

Tarring Outfits—
- 1-2 bbl. capacity .....1.00 per day
- 3-5 bbl. capacity .....2.00 per day

Gang Outfits—
- For wheelers, plows, slips and small tools....2.50 per day

(Gang crew to carry their own grader for gravel work and not use patrolmen on gang work.)

Miscellaneous Equipment—
- Oil distributors ..... 1.50 per day
- Concrete Mixers, ½ bag .....1.00 per day
- Concrete Mixers, 1 to 2 bag .....2.00 per day
- Air compressors .....0.28 per hour
- Dump Wagons (each) .....0.75 per day
- Haney scrapers (each) .....1.00 per day
- Cook and sleeping wagons .....0.50 per day
- Sweepers .....0.20 per hour
- Large road planers .....0.10 per hour
- Screening plant .....0.07 per day

The rental prices set forth cover depreciation, maintenance, overhauling, fuels, lubricants and insurance.

Recent Kansas Sewage Treatment Plants

Three sewage treatment plants have been completed recently in Kansas, each using Imhoff tanks, but differing in the method of secondary treatment. At Troy the Imhoff tank effluent is treated on sand filters, at Hugoton by surface irrigation, and at Ness City by sprinkling filters.

South Willard Street, Burlington, Vt., paved with Standard Refined Paving Asphalt.

STANDARD ASPHALT PRODUCTS

(Socony Brand)

Standard Asphalt Binder A
for surface treatment

Standard Asphalt Binder B
for penetration work

Standard Asphalt Binder C
for the mixing method

Standard Asphalt Joint Fillers
for brick or block pavements

Standard Cold Patch Asphalt
for repairing all types of bituminous road surfaces

Standard Refined Asphalt
for sheet asphalt paving

Standard Paving Flux
Bridge Asphalt and Preserving Oils

SOCONY ASPHALTS AND ROAD OILS

Specifications and all other particulars furnished on request

STANDARD OIL COMPANY OF NEW YORK

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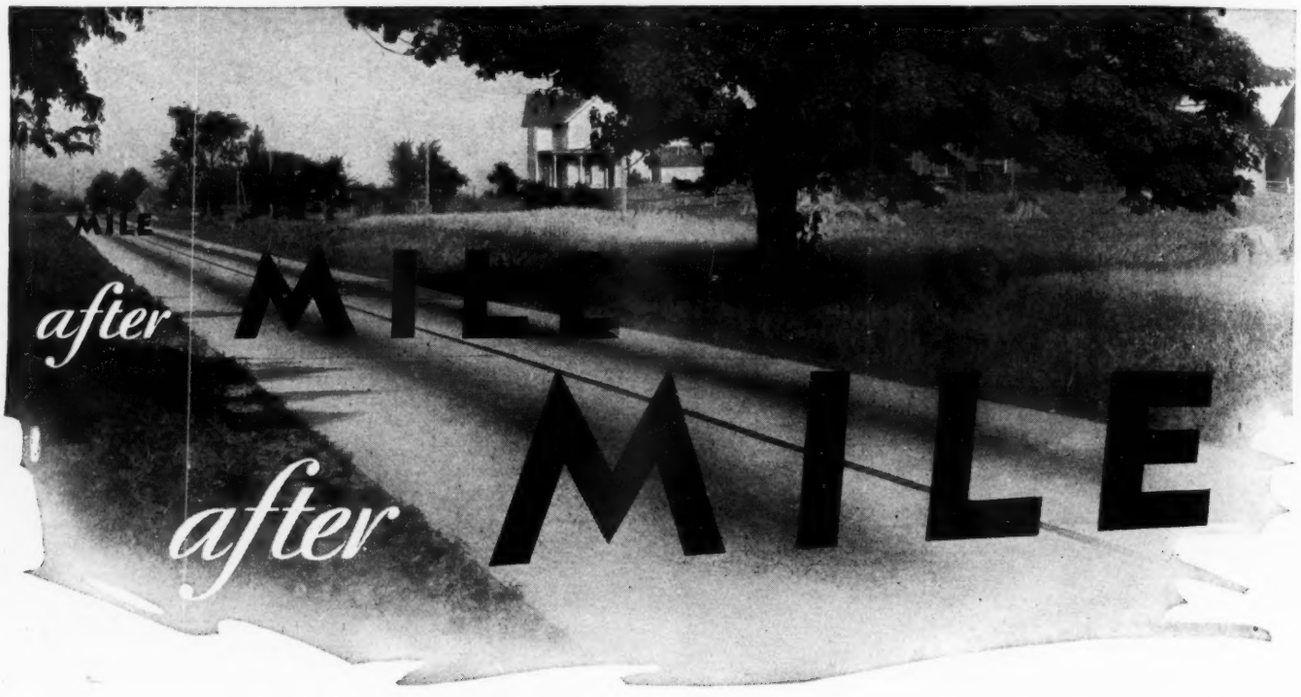

. . . . and all that's needed for the curing job is one man, a spreader, and some Calcium Chloride . . . . . .

Method of curing concrete by the use of Calcium Chloride on the surface or as an admixture are both approved by the United States Bureau of Public Roads.

No big final clean-up is needed where concrete roads are cured with a surface application of Flake Calcium Chloride. After the man with the spreader applies the Flake Calcium Chloride on the surface, this clean white material takes care of itself just as it takes care of the entire curing operation. No need for constant sprinkling and inspection, either.

No wonder Calcium Chloride has been chosen to do the curing job on thousands of miles of the best concrete highways. Besides assuring perfect curing, the Calcium Chloride methods provide advantages that appeal to everyone concerned with a concrete road, from the men who plan and build it to the taxpayers who pay for it and use it.

The full facts are presented in the information which will be furnished by any of the companies sponsoring this advertisement. Write today and ask for booklet 842.

CALCIUM CHLORIDE PUBLICITY COMMITTEE
SOLVAY SALES CORPORATION - - - - - - - - 61 Broadway, New York
THE COLUMBIA PRODUCTS COMPANY - - - - - - - - Barberton, Ohio
THE DOW CHEMICAL COMPANY - - - - - - - - - - Midland, Michigan

FLAKE
CALCIUM CHLORIDE
CURES CONCRETE

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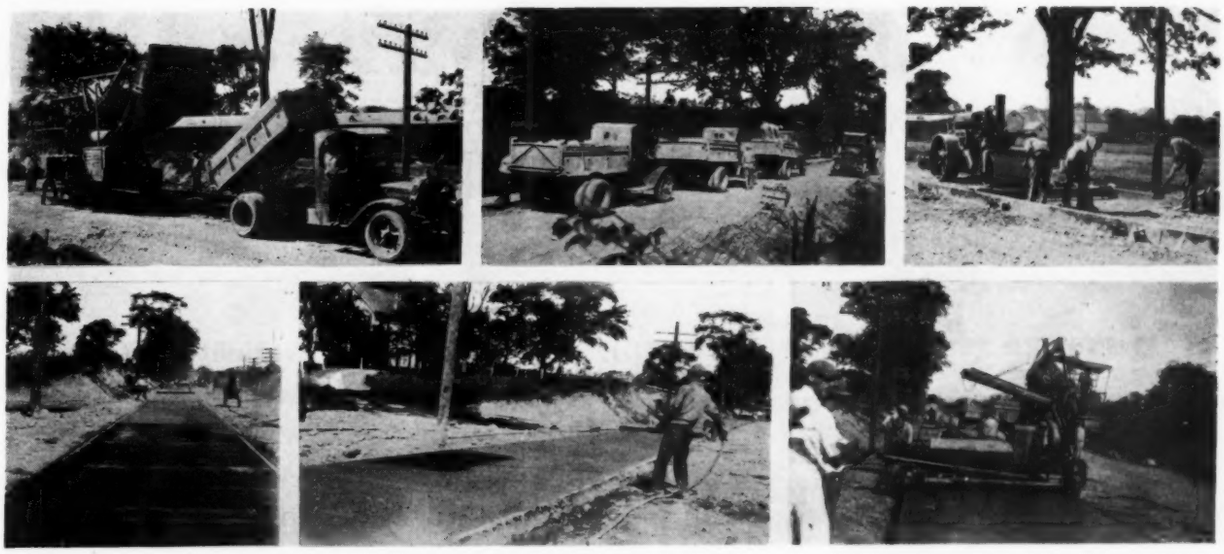

Fig. 1. Panorama of the Lane Constr. Co. Job. Above: placing forms and fine grading, batch trucks lined up, and Foote mixer operating; below: the finishing processes, with screed at right, applying the Barber "Curcrete," and, left, the finished pavement.

Relocation and Paving Along New York Route 17

ROUTE 17, which carries exceedingly heavy traffic from New York City to the southern Catskills, is being reconstructed throughout a large part of its length. The work involves extensive relocation, and the construction of two-lane and three-lane concrete pavement. For the most part, the relocation carries the highway outside of the villages through which the old road passed.

Two construction jobs on Route 17 near Liberty were described in the issues of PUBLIC WORKS for September and October, 1929. These were both two-lane highways, 20 feet in total width, and one of them involved additional grading to allow the construction, when necessary, of another lane. This year, an extra lane was added on a 4-mile stretch near Monroe, N. Y., and the job described in this article continues the three-lane highway northward to Goshen. In addition, work is under way just south of Monticello, and an additional contract is soon to be let for the section over the Shawangunk Mountains north of Middletown. The completion of these projects will provide a high-speed road from the New York state line at Suffern (where connection is made with three important New Jersey roads) direct to one of the most popular resort sections of New York state.

The widening work extended northward from Monroe, and consisted of the construction of an additional 9-foot lane by the Lane Construction Corp., Meriden, Conn. Much of the grading was done last fall and winter and the paving was started early this spring, so that the road will be completed and put into service before the heavy traffic of the summer season. The same contractor constructed the three-lane continuation of this road from Chester north to Goshen, using the same methods and equipment, which are described in this article.

This contract was for somewhat more than four miles of three-lane pavement, each lane 10 feet wide. Much of the work was on new location which was made to eliminate a dangerous, narrow, overhead crossing and also to by-pass the village of Goshen, in which was a grade crossing over the tracks of the Erie railroad, and the streets of which were too narrow to handle the heavy traffic on Route 17. Also, just beyond the village were two other grade crossings, though these were branch lines and handled but ltttle railroad traffic. Thus the relocation eliminated one dangerous overhead bridge, three grade crossings, one of them very bad, and the delays and dangers incident to handling traffic through the village.

The plant used by the contractors was described in the November, 1929, issue of PUBLIC WORKS, and the construction methods employed are, in general, the same as were used on that job. The grading was handled principally by an Erie steam shovel. Fig. 2 shows some of the hard digging encountered on the job. In the cut illustrated, the hardpan soil had become so baked by the hot, dry weather as to be almost as difficult to handle as rock. Trucks, mostly 5-ton Macks, handled the excavated material to fills or dumps. The surface was then brought to approximate grade with a Galion grader, and about 8 inches of gravel was placed and leveled in preparation for the pavement.

Mataforms were used, and were set about 1,000 feet in advance of the mixer, which was a Foote 27E. Two-batch trucks, nearly all 3-ton Macks, were used for bringing up the aggregate. An Ord finisher was used. Barber Curcrete was applied as a finishing agent, which eliminates the troubles and costs of using hay or covering the pavement with earth and has proved very satisfactory on this job. One man handles the entire job of application.

(Continued on page 50)

How 52 Leading RELIEVE

THE United States Department of Commerce has recently made telegraphic inquiry of 52 leading cities to ascertain whether water works construction and other public work projects are being pushed forward as an unemployment relief measure. Replies by letter and telegram indicate that leading American cities recognize that one way to prevent bread lines is to extend pipe lines.

A majority of these 52 cities are finding it possible to advance public work, and in particular, water works construction in order to help relieve the present unemployment crisis. Within the past thirty days, thousands of men have been put to work laying underground pressure pipe for water and gas mains.

This humanitarian, as well as extremely practical program must merit the highest commendation of all citizens—of merchants, manufacturers and bankers—as well as municipal and government officials. Cities adopting this plan are providing an immediate remedy for unemployment distress lest it become more acute as winter approaches.

Cities are helping to

UNEMPLOYMENT

Every city, large or small, should be doing now all it can to relieve unemployment by (1) pushing forward water works extensions or projects planned for next year; (2) anticipating future requirements; (3) rushing to completion work in progress. A municipal water works system is rarely without need, present or imminent, of some extensions, replacements or improvements. Few types of public works construction offer equal opportunity for immediate unemployment relief.

Where appropriations are required, tax agitators should not be permitted to obscure the fact that money spent for permanent improvements that give *employment* is preferable to money spent for *unemployment relief.*

Unemployment relief is a vital reason for the passages of bond issues for necessary public works' appropriations that will be voted on at fall elections.

This advertisement is published by the Cast Iron Pipe Research Association as a contribution to the Government's program of stimulating public works construction to improve business and relieve unemployment. For information and counsel, interested municipal officials are invited to write to Thomas F. Wolfe, Research Engineer, The Cast Iron Pipe Research Association, 309 Peoples Gas Building, Chicago, Illinois.

Read these excerpts* from recent telegraphic reports by leading cities to U. S. Department of Commerce.

"... extensions approved expedient by... Board of Estimate to alleviate water shortage and assist unemployment situation."

* * *

"Already plan to hurry work this winter for purpose of employing labor."

* * *

"The city administration is doing everything it can to provide employment on this and other kinds of public improvements."

* * *

"Work will continue through winter, weather permitting, thus giving steady work to large numbers of laborers."

* * *

"... the entire ... sum now available will have been contracted for and work will be under construction before the end of this year."

* * *

"All of this money, which is now available, is being expended in such a way that there will be a constant demand for employment and every effort will be made, and is being made, to put the workman back on his job."

* *Supplied by Department of Commerce without revealing the sources of the communications from which the excerpts are taken.*

Advancing Water Works Construction Projects Offers Immediate Unemployment Relief

The *classified* INDUSTRIAL LITERATURE section is your guide to the latest catalogs—see page 71

The mixer operated outside the forms in constructing the first lane, this being necessary because of the overhead wires. This probably slowed the work of the mixer slightly and made necessary the employment of an extra man on the mixer gang to handle the overflow and waste from the mixer and mixer bucket and to clean up around the mixer.

Stone is provided from a local quarry about three miles away, and sand from a bank in the edge of the village of Chester. (Both of these plants were described in the November, 1929, issue of PUBLIC WORKS.) The batching plant is located at Chester. An Erie steam crane loads the aggregate into a Johnson batching bin. The number of trucks on the job, all of which are hired, has ranged from 8 to 15.

Fairly good progress has been maintained, the mixer averaging between 1,300 and 1,350 feet of 10-foot pavement per day, or close to 1,500 square yards per day, when not hindered by having to maintain traffic. A good deal of trouble has been caused by drivers turning onto uncured concrete, despite heavy barriers.

On the job south of Monticello, which will tie into the 15-mile stretch completed last year from Monticello through Liberty, 11 miles north, concreting has not yet begun but considerable progress has been made in grading, and two mixers will be placed in operation shortly. From Rock Hill on the south to Monticello, the grading will be very heavy. Five power shovels are at work on this section. On the heavy grade south of the Neversink river, the Echo Contracting Co. of Fort Lee, N. J., has a Moore Speedcrane with a 1-yard bucket making a deep cut to reduce the grade. This shovel is loading into 5-ton Mack trucks. Other equipment includes a McCormick-Deering tractor bulldozer. Just below is a 20-B Erie steam shovel loading into Mack and Brockway trucks. A little beyond is a Northwest gas shovel on shallow grading, which loads into Macks. Further on are two Erie steam shovels on heavy cuts.

The completion of these jobs late this fall and early next spring will leave but one or two stretches of this much-traveled road to be reconstructed. Objections on the part of some of the villages along the old road to by-passes which would cut them off from through traffic, and difficulty over right-of-way, have temporarily held up these sections.

Snow Removal Costs 55 Cents Per Motor Vehicle

Manitowoc County, Wisc., which borders on Lake Michigan, has a 28-year average snow-fall of 48.9 inches, but the fall for the winter of 1929-30 was slightly below this figure. The automobile registration shows 14,317 motor cars, 2,512 trucks and 5 buses. There are 275 miles of country trunk roads.

Edward Berkedol, highway commissioner, reports that the state and county trunk roads were kept open last winter, and work was done also on a number of town roads. The total cost was $9,304, an average cost per mile of $33.83; or of 55 cents for each motor vehicle.

Manitowoc County's snow removal equipment includes 6 FWD motor trucks, one single blade, 7 "V" type plows and 2 tractors. No rotaries are used. About 15 miles of snow fence is employed, and saves a large amount of work. When judiciously placed, it prevents drifting in many places that otherwise would require plowing.

Painting Creosoted Guard Fence Posts

Some states increase the durability of wooden posts used for highway guard fences by creosoting them. But creosoted wood does not take or hold paint well, and when the wire cable is used it is difficult to make the fence visible at night. The Oklahoma State Highway Department has had success in painting creosoted posts with aluminum paint for two years past and Kansas for a year. Oklahoma finds that creosoting with 8 pounds by the empty-cell treatment permits more satisfactory painting than 12 pounds by the full-cell treatment.

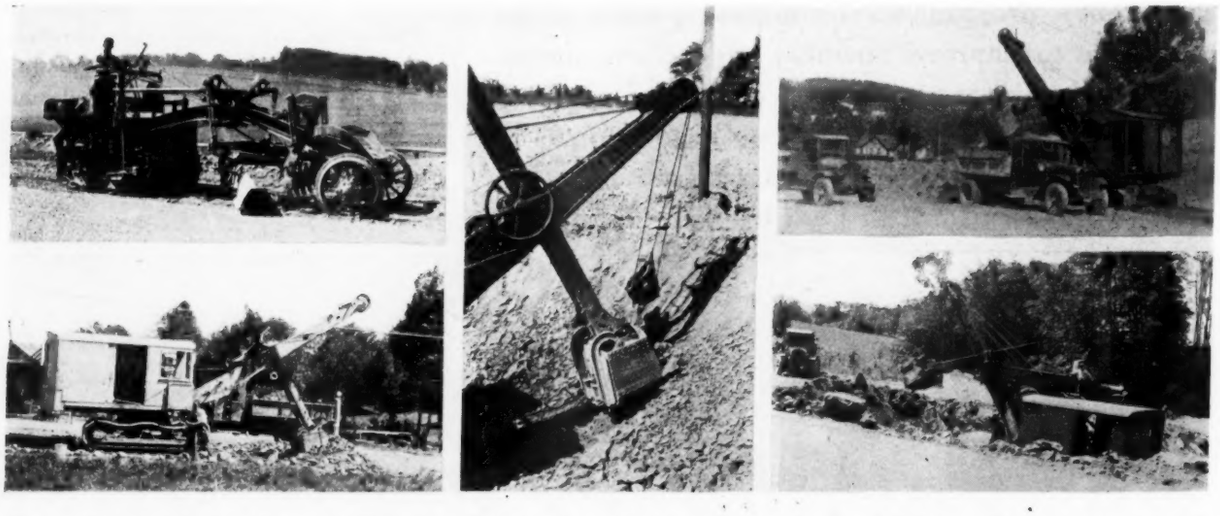

Fig. 2. Heavy work along Route 17: Center, an Erie shovel in a hard cut. Right, above, a 20-B Erie and below a Moore Speedcrane working on the mountain just south of the Neversink River. Left, above, a Galion grader spreading the gravel on the Lane job, and below, a Northwest Shovel taking a shallow cut.

The answer to tough paving problems... at considerably lower costs

Bit-u-muls

"HEAVY TRAFFIC" *Pavement* *at* "LIGHT TRAFFIC" *Costs*

Introducing entirely new principles in road construction, and eliminating many previous difficulties . . . Bitumuls construction combines the meritorious features of the two well-known hot asphaltic types . . . and, at considerably lower costs.

Durable, rock pavements, with live, sticky asphalt to waterproof and bind them . . . Bitumuls introduces revolutionary possibilities in road construction. Voids are reduced to a minimum. And there is no excess asphalt used . . . hence, no shoving and surface bleeding.

No heating costs

Application may be with the popular types of gravity or pressure distributors, or with ordinary pouring pots. No heating costs whatever.

Many months are also added to your construction season . . . because Bitumuls pavements can be built at any atmospheric temperature, except freezing weather . . . and in damp, or even mildly rainy weather.

To stretch your paving dollars . . . on secondary-road work, primary roads, city streets, subdivisions, widening, resurfacing, maintenance, and airports . . . investigate Bitumuls low-cost construction. It is backed by years of extensive research, and widespread use throughout the world.

Be sure that your specifications measure up to Bitumuls . . . for more economical paving.

For Manual, with detailed facts, technical facts, and specifications . . . mail the coupon below.

Make this practical test

Order a sufficient number of barrels of Bitumuls to make a thorough test. Have your regular paving crews apply it . . . in small areas . . . with ordinary gravity or pressure distributors, or with pouring pots. See for yourself the amazing possibilities of Bitumuls in your pavement construction and maintenance . . . its low cost . . . its durability . . . its non-skid surface.

AMERICAN BITUMULS COMPANY—Branches throughout the world
Baltimore · Baton Rouge (La.) · Boston · Cincinnati · Los Angeles · San Francisco · St. Louis

Please mail me your free manual . . . without obligation

Name_____ **Address**_____

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Culvert Pipe for State Highways

Kinds of material, diabeters, thicknesses, strength and test methods provided for by specifications of highway departments.

INFORMATION concerning the kinds of culvert pipe provided for by the specifications of the several state highway departments has been compiled by the American Road Builders' Association, assisted by the Bureau of Public Roads. The following is a condensed statement of the information tabulated by the association:

Kinds of Pipe Used

Cast-iron pipe is specified by 36 states. Those not specifying it are Arizona, California, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Carolina, Utah, Washington and Wyoming.

Corrugated metal pipe is specified by all the states, each calling for pure iron, copper-bearing pure iron, copper-bearing iron, copper molybdenum iron, or copper steel; except that copper steel is not mentioned by Connecticut, New Hampshire or South Carolina, nor molybdenum by Oklahoma.

Vitrified clay pipe is specified by 40 states. Those not specifying it are Arizona, Idaho, Minnesota, Montana, New Mexico, Rhode Island, South Dakota and Utah.

Reinforced concrete pipe is specified by all states except Nevada, Rhode Island and Wyoming.

Plain concrete pipe is specified by the following 15 states: Alabama, Arizona, California, Georgia, Kentucky, Maryland, Massachusetts, Michigan, New Mexico, North Carolina, Ohio, Pennsylvania, Virginia, Washington, West Virginia. Details of plain concrete pipe were not compiled by the association.

Diameter

The minimum and maximum diameter of each kind of pipe provided for in the specifications of the several states are as follows:

For *cast-iron* pipe, 12 inches is the minimum diameter in all states except as follows: Indiana, 4″; Kansas, 15″; New Jersey, 10″; Tennessee, 18″.

The maximum diameter is 36″ in all states except as follows: Alabama, New Jersey and New York, 48″; Indiana, 60″; Missouri, 30″.

Corrguated metal pipe, minimum diameter is 12″ in all states except as follows: 8″ in Ohio; 10″ in Massachusetts and New York; 15″ in Arizona, Colorado, Iowa, Kansas, Nevada, Tennessee; 18″ in Missouri, Nebraska and New Mexico.

The maximum diameter is 36″ in 28 states, being all except the following: 30″ in Indiana; 42″ in North Dakota and Oregon; 48″ in Arkansas, Idaho, Maine, New York, Ohio, Washington and West Virginia; 60″ in Arizona, California, Massachusetts and New Jersey; 72″ in Delaware, Illinois and Wisconsin; 84″ in Missouri and Nebraska.

Vitrified clay pipe: Minimum diameter, 12″ in all states, except 4″ in Kentucky, Ohio and Vermont; 6″ in California and Indiana; 8″ in Maine; 15″ in Kansas, Missouri and Tennessee; and 18″ in Nebraska; with eleven states not specifying either minimum or maximum diameter.

Maximum diameter, 42″ in ten states—Arkansas, Louisiana, Maryland, Nebraska, Ohio, Oklahoma, Pennsylvania, Texas, West Virginia and Wisconsin; 36″ in eight states—Indiana, Kansas, Kentucky, Missouri, North Dakota, Oregon, Virginia and Wyoming; 30″ in eight states—Alabama, California, Delaware, Florida, Mississippi, North Carolina, South Carolina and Tennessee; 24″ in two states—Maine and Vermont; 18″ in Washington.

Reinforced concrete pipe: Minimum diameter, 12″ in all states except as follows: 10″ in Indiana; 15″ in Iowa, Kansas, Missouri, North Carolina, South Dakota and Tennessee; with twelve states not specifying either minimum or maximum diameter.

Maximum diameter, 84″ in two states—California and Wisconsin; 60″ in six states—Connecticut, Delaware, Maine, New Jersey, Ohio and Virginia; 48″ in thirteen states—Arizona, Kentucky, Louisiana, Michigan, Missouri, North Carolina, Oklahoma, Oregon, Pennsylvania, South Dakota, Utah, Washington and West Virginia; 42″ in five states—Alabama, Florida, Iowa, Mississippi and South Carolina; 36″ in five states—Idaho, Kansas, Montana, North Dakota and Vermont; and 30″ in two—Indiana and Tennessee.

Minimum Wall Thickness

Cast-iron pipe: For 10″ pipe, 3/16″. For 12″ pipe, ⅜″ in eighteen states, 7/16″ in eight, 5/16″ in one and 0.54″ in one. For 18″ pipe, ½″ in one. For 30″ pipe, ⅝″ in one. For 36″ pipe, 11/16″ in eighteen: 12/16″ in one; 13/16″ in six; and 0.99″ in one. For 48″ pipe, 11/16″ in one; 15/16″ in one; 22/16″ in one. For 60″ pipe, 1.39″ in one.

Corrugated metal pipe: 16 gauge metal is used for all sizes under 24″ pipe in all states, except that 14 gauge is specified for 15″ pipe in Kansas and for 18″ pipe in Missouri and Nebraska. 14 gauge metal is specified for 30″ pipe in Indiana and for 36″ pipe in Nevada. 12 gauge is specified in 36″ in twenty-seven states; also for 42″ in two states and for 48″ in four states and 60″ in one. 10 gauge is specified for 48″ pipe in two states, for 60″ in one, for 72″ in two and for 84″ in two. And 8 gauge is specified for 48″ in one state, for 60″ in two and for 72″ in one.

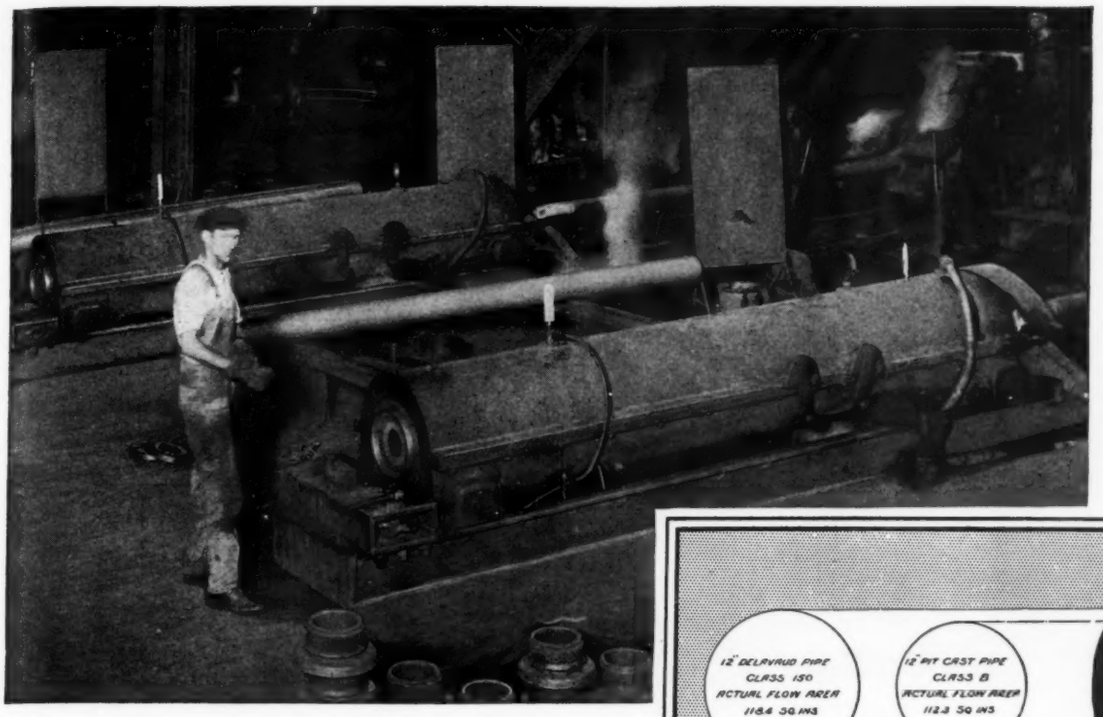
Vitrified clay pipe: For 4″ pipe, 9/16″ in two states and ½″ in one. For 6″ pipe, ⅝″ in two states. For 8″ pipe, ¾″ in one. For 12″ pipe, 1″ in 17 states and 1¼″ in two. For 15″ pipe, 1¼″ in one state, 1½″ in one, and 1⅞″ in one. For 18″ pipe, 1½″ in two. For 24″ pipe, 1⅝″ in one state and 2″ in one. For 30″ pipe, 2½″ in six states, and 3¼″ in one. For 36″ pipe, 2½″ in two states, 2¾″ in three states, 3″ in one, 3¾″ in two. For 42″ pipe, 3″ in five states and 3½″ in five.

Reinforced concrete pipe: For 10″ pipe, 1⅞″ in one state. For 12″ pipe, 1″ in one state, 2″ in twenty, 2¼″ in one and 2½″ in one. For 15″ pipe, 2″ in one state and 2¼″ in four. For 30″ pipe, 2¾″ in one state and 3½″ in one. For 36″ pipe, 3¼″ in two states and 4″ in three. For 42″ pipe, 4½″ in four states. For 48″ pipe, 4½″ in two states, 5″ in eight and 6″ in one. For 60″ pipe, 5″ in one state and 6″ in five. For 84″ pipe, 8″ in one state. Sixteen states permit a lower minimum thickness for machine-made pipe.

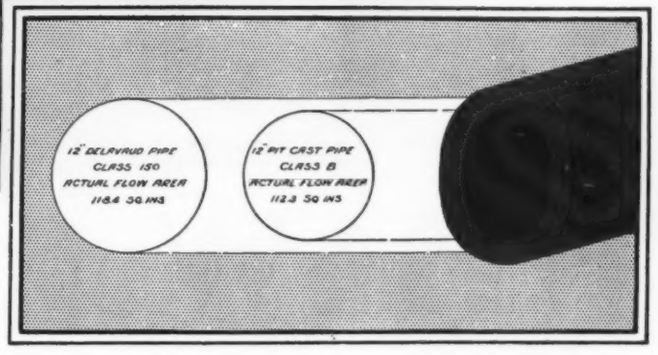
Strength Requirements and Test Methods

All states specifying tests of pipe call for the use of the 3-edge bearing method for all kinds of pipe (except corrugated, for which no such test is required); except that California specifies sand bearing for vitrified clay; California and Idaho provide for both 3-edge and sand for reinforced concrete; and

(Continued on page 64)



Above· The deLavaud machine in operation.



Below: Graphic illustration showing the greater carrying capacity of de Lavaud pipe.

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Eliminating Suspended Matter From Water*

General discussion of intake racks, both coarse and fine screens with and without automatic cleaning, and provision for sedimentation.

SURFACE water carries suspended matter in varying quantities during a large part of the year—slush ice in winter; silt and sediment after spring freshets, with the winter's accumulations of logs, brush, pine needles and miscellaneous debris. In summer some streams may run clear most of the time, but others have periodical runs of algae. In the fall come leaves, which may block racks and screens, accumulations of which are the main cause of vegetable stain.

While stain or turbidity originating in colloidal clays can be removed only by special treatment, most surface waters can be greatly improved by screening and sedimentation. The first aim should be at least a moderate storage and sedimentation basin above the intake. Generally some form of dam is quite essential to check the water, induce settling, and give head for operating sluiceways and screens.

The intake itself should be placed in the deepest available water. If the stream curves, it is advantageous to place it on the concave side of the curve, since both sediment and floating debris swing to the outer or convex side. To divert the water so as to exclude floating material, the best way is with some form of boom—at least a surface baffle board for a small inlet. To minimize the entrance of heavier solids into the intake, the floor or sill should, if possible, be placed above the bed of the stream. The heavier gravel and sand, which can not be picked up by the current or carried in suspension, rolls along the bed of the stream and will not enter a higher inlet. If there is no dam it will pass on down the stream. With a dam, it will accumulate; and to remove it and prevent building up to the level of the intake floor, a sluice gate should be built in the dam and opened frequently.

Sufficient consideration is too seldom given to intake racks. We often find racks that can be reached and cleaned only from a boat or by an acrobat; or with cross members which catch the teeth of the rake and entangle debris; or even with coarse mesh or gratings which defeat convenient cleaning. A general rule may be stated that, while size and spacing of rack bars should fit the case in hand, all racks should be placed on a slope of 2 to 4 inches in 12, with a working platform at the top. We used to string rack bars on rods with pipe spools or spacers between, but the development of welding makes it possible to support the bars from the back and leave a deep space to clear the teeth of the rake used for cleaning.

Intake Screens

After the water has passed the racks, the next feature is the intake screen. Its purpose is to remove twigs, leaves, grass, roots, moss and other suspended debris. The larger water works intakes usually have fairly efficient screen arrangements, and where men are continually on duty at the intake, the question of screen maintenance is not serious, though it may be exacting during flood and leaf seasons. The real problem comes at the small water works intakes. In the Pacific Northwest we have many gravity water supplies ranging from 250,000 to 5,000,000 gallons with intakes 10 to 15 miles from town. Obviously, such plants cannot afford to keep a regular man at the intake, and their screen layouts are usually the crudest and least effective. Trouble at the intake is commonly indicated by a falling off of the supply, and the superintendent must drive or walk up to the intake to clean the screens. In leaf seasons the cure is but temporary and the maintaining of the screens is a continual nuisance and expense.

For the larger water works plants there have been developed continuous screens of the Rex type which are efficient and require little manual attention. They are, however, made in large units only, expensive, and require power and water under pressure for their operation. For small supplies, where the trouble is most serious, they are not adaptable and there is a very definite need and demand for a screen arrangement or device which is at least partly automatic in action and self-cleaning; something which will operate for a day or several days in leaf season without attention.

One intake arrangement, adaptable to quite small supplies, a million gallons or less, is based on the principle that suspended material tends either to sink or float. It uses a relatively large area of screen, giving low velocities. It also uses a screen made up of vertical wires or bars only. The reason for this was the observation that the horizontal wires of a mesh catch leaves or roots and hold them against floating or sinking. A leaf drifting against the vertical wire screen will usually slip up or down, more often down, clearing the screen area. If it comes to the top, it floats into the space provided, and if water is being wasted, goes over the spillway. Material that accumulates below the screen may be blown off by opening the gate. This screening principle has been tried out in various designs and is effective.

A more completely automatic leaf screen, applicable to any volume of supply and used up to 24,000,000 gallons, has as its only limitation the requirement of a small operating head and the necessity of wasting 5% to 10% of the flow. This screen is carried on a rotating drum, turned by current action upon interior vanes. The water passes through the screen and out at the open ends. The material retained upon the screen is carried down to the bottom, where a back washing action removes it to the waste. This screen is still in the course of experimental development, but has been found completely successful in removing everything that is retained upon the size of mesh used, with only occasional attention and service.

Sedimentation at Intakes

Aside from a dam at the intake, most water works systems offer no sedimentation until the water reaches a reservoir. The author believes that the place to remove settleable solids is at or close to the intake, and not after they have passed through a long trans-

*Abstract of paper by J. W. Cunningham, of Baar & Cunningham, Portland, Ore., before the Pacinc Northwest Section of the American Water Works Ass'n.

mission or supply main. Further than this, engineers are urged to study the results from a relatively short period of sedimentation under the most ideal conditions for such action. Based upon some recent installations at water works intakes, and experience in the sedimentation of sewage, the writer is of the opinion that a settling chamber having a capacity of ½ hour's flow or less, properly designed and baffled, will be very effective with most of our surface waters. It will materially reduce the turbidity and will get rid of the heavier sand and silt which is most objectionable if it gets into the line.

A small settling box, as suggested, will usually fit into the remainder of the intake design and will be relatively inexpensive. If the bottom is sloped, and wash water and cleanout gates are built in, the accumulation of silt can be blown out frequently, giving very little hand work. Such a settling box is well adapted for combination with rotating intake screens already described.

Fine Screens

The ordinary intake screen has from 2 to 4 meshes per inch. Often a coarser mesh screen is placed ahead of the smaller mesh, but we very seldom see any screen finer than 6 mesh. Anything passing such a screen goes into the system unless later settled out in a reservoir. The reason for not using a finer mesh in water works practice is undoubtedly the increased clogging and difficulty of cleaning fine screens. There is, however, a definite field and opportunity in the use of fine screening. (The classification of fine screens here used includes anything smaller than 8 meshes to the inch.) There are situations where fine screening may remove the necessity for filtration. For example, in the manufacture of certain grades of pulp and paper the main objection is to material which causes clogging in showers and washers, which is not taken out by ordinary mesh but may be removed by fine screens. This material includes fine hairlike roots, pine needles, moss and certain forms of algae.

The limit of fineness to which screening is practicable is a question. It depends upon character of the water, screen design, and the cost that the undertaking will stand. In general, the finer the screen, the lower the velocities and the larger the screen area which must be provided. One requirement to be met in the design of fine screens is easy maintenance. Such screens, if effective, must be kept clean and they should be made either self-cleaning or quickly and inexpensively cleaned by hand.

A necessity for fine screens is to secure a low velocity and a uniform distribution of flow over the entire area. Short circuits and dead spots make the screen less effective and less economical. One upward flow screen uses weirs to distribute the water. The object of the upward flow is to permit washing down the screen by the use of a hose stream. If brushing is necessary the screen sections may be tilted up. Gates provide for control, washing and waste operations.

The aim of this paper is to emphasize the fact that a water works intake and screening plant is of an importance which deserves much more thorough study and careful design than it usually receives. The man who operates the plant usually realizes this more fully than the engineer who designed it. The engineer, however, is in a better position to apply the various hydraulic and mechanical principles which go into the design if he will only do so.

Tandem Pavers in Concrete Road Construction

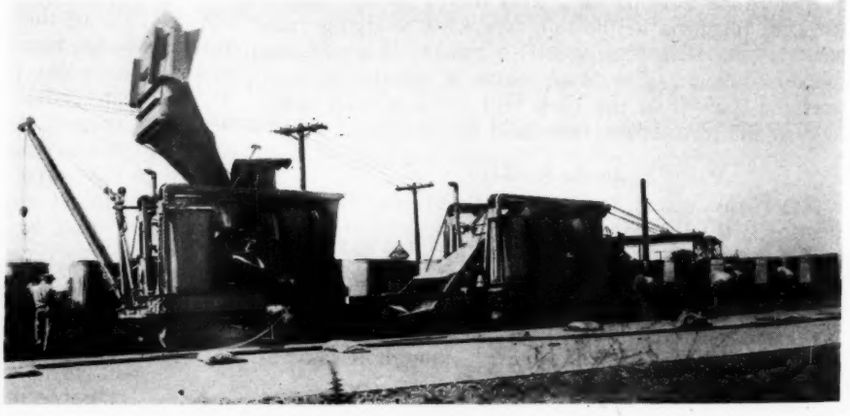
In laying a 4-mile 40-foot roadway in Cook County, Illinois, Jaicks Brothers Construction Company operated two Koehring 27-E Pavers, hitched tandem. This unusual set-up enabled the company to turn out 65 to 70 batches of one-minute mixed concrete per hour, as compared to 40 to 45 batches, the usual output of a single paver with a one-minute specified mix. By simply adding one operator to the regular crew, the company increased its daily concrete production by 50 per cent.

The two pavers are rigidly held the same distance apart by a 10 x 10 timber. The distance between the pavers must be kept constant, so that the partially mixed concrete discharged from the first paver will drop into the skip of the second paver without spilling or overlapping.

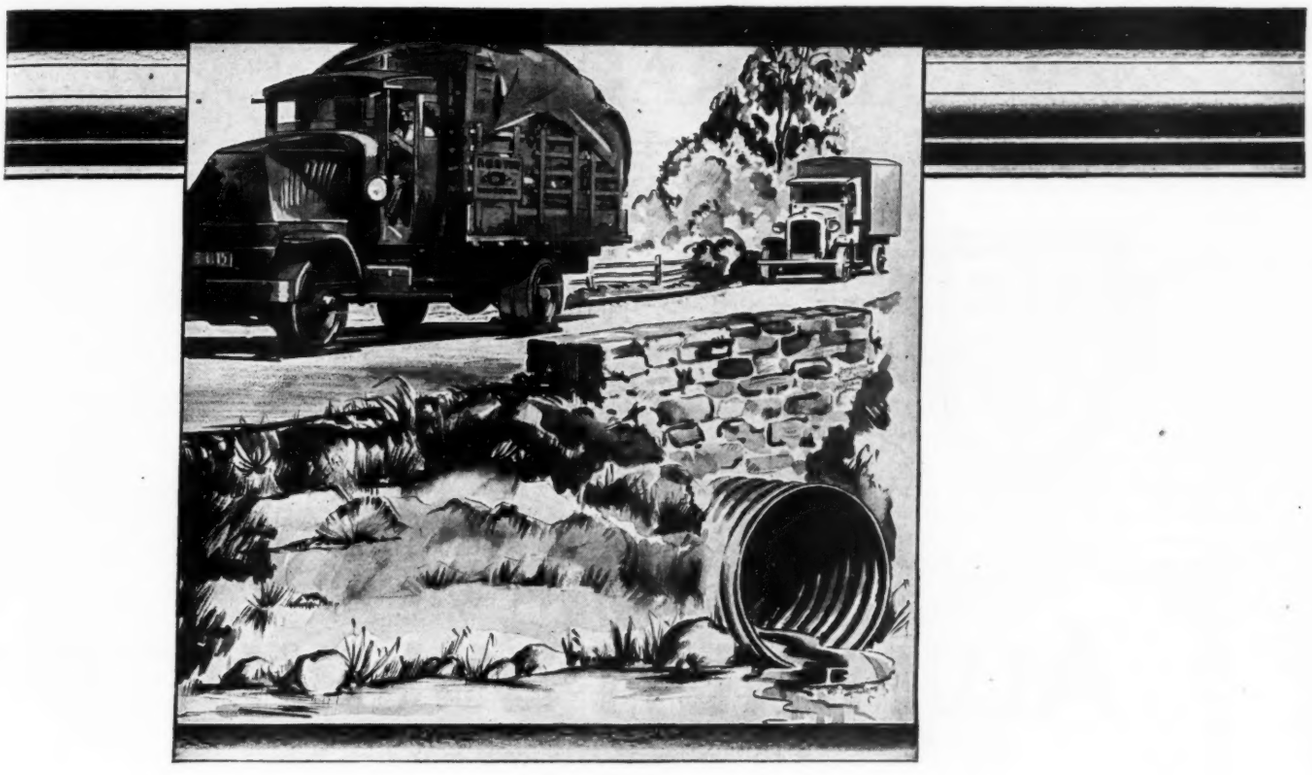
Materials are proportioned by volume in a central proportioning plant and transported in batch boxes to the first paver by means of an industrial railway. The paver derrick hoists the boxes for charging the skip. All the water is taken into the batch by the first paver, which mixes the charge for 26 seconds. The partially mixed materials are then discharged into the skip of the second paver which mixes it an additional 34 seconds—making the total mixing time one minute. The resultant concrete is discharged into the distributing bucket of the second paver, and placed on the subgrade in the usual manner.

Water-Softening at Iola, Kans.

The new water purification and softening plant at Iola, Kans., has been completed and is now in operation. The new plant is modern in every detail, and the softening equipment includes recarbonation. The new plant supplements the plain settling basins which have served the city for over twenty years. Zelby Taylor, formerly chemist with the Lattimore Laboratories at Topeka, is chemist in charge of filtration.



Tandem mixers give fifty percent greater output than a single mixer with only one extra man.



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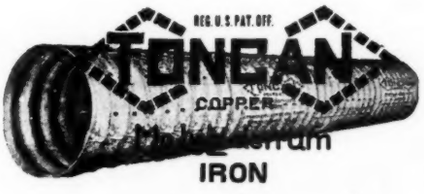

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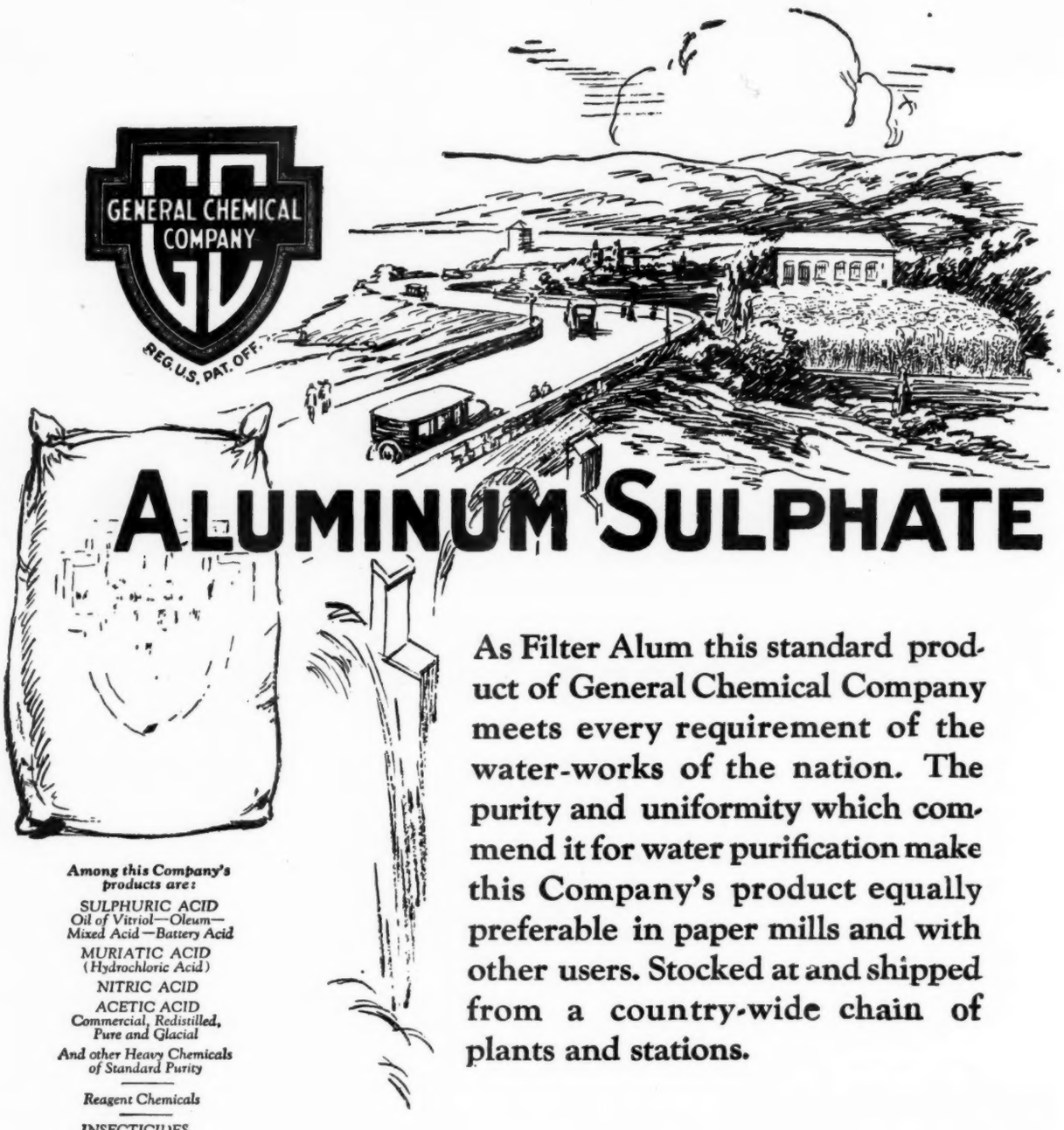

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RECENT LEGAL DECISIONS

Proposals and Bidding Sheets Held Invalid As Discriminatory

Proceedings culminating in the award of a contract for a street improvement were set aside because the proposals and bidding sheets left open to each bidder to designate the number of working days in which they would perform the work, in violation of New Jersey Home Rule Act, Art. 11, section 5.

Also, the bidders were required to bid upon certain quantities and sizes of cement pipe for subdrainage, and the specifications and contract contained no requirement therefor, and such items constituted a part of the bases of estimating the standing of the bidders. The court said that the fact that the successful bidder bid extremely low on these items and that, excluding its bid on these items, it would not have been the lowest bidder, placed the bona fides of these items in doubt, inclining to the conclusion that the bidding was not open to equal opportunity to all bidders.—Jordan v. Borough of Dumont, New Jersey Supreme Court, 146 Atl. 49.

Contractor Injuring Telephone Conduit Held Not Liable In Absence of Negligence

The Washington Supreme Court holds, Pacific Telephone & Telegraph Co. v. Slezak, 276 Pac. 904, that a contractor constructing a bulkhead in a street for the city is the agent of the city and therefore liable to no greater extent than the city would be for driving a spike into a telephone company's conduit, causing a short circuit. The city could not be held liable for trespass in such a case, but only for want of due care. Here there was no willful trespass. At most it could only be a lawful act negligently done. Where the jury found there was no negligence, judgment for plaintiff notwithstanding the verdict was held error.

City Held Not Generally Liable to Contractor for Unpaid Assessments

Under the charter of a city the cost of paving improvements was to be assessed to abutting property owners specially benefited. The work was done and warrants were drawn on the special funds in payment thereof. Some owners refused to pay the assessments and their property was duly advertised for sale. No bidders appearing who would pay an amount equal to the assessments levied against the property, it was struck off to the city. The Oregon Supreme Court held, City of Newberg v. Warren Const. Co., 278 Pac. 96, that the city did not incur a general liability to the contractor for the unpaid assessments, where it did everything within its charter powers to create, by special assessment proceedings, sufficient funds to pay the warrants issued. The contractors were bound to take cognizance of the city's charter powers. The charter provisions, by implication, became a part of the contracts between the city and the contractors.

Applicability of Statutory Procedure to Municipal Improvement

The Utah Supreme Court holds, Barnes v. Lehi City, 279 Pac. 878, that a statute providing that when a city contemplates making an improvement, to be paid for out of the general funds of the city, the city must cause plans and specifications to be made, together with the estimated cost thereof, and then advertise for bids, does not apply to improvements which are to be paid for exclusively out of the proceeds of the improvements, which proceeds are not and do not become a part of the general funds of the city.

Paving Contractor's Agreement With City to Use Patented Materials Where Patent Afterwards Found Invalid

A paving company entered into contracts with a city for paving two streets, each of which contracts expressly required the paving to be in accordance with a patented process. The paving company proceeded to make this mixture, which consisted, generally speaking, of a mixture of asphaltic binder, sulphate of copper and a filler of finely ground soil, at its own plants. The patentee obtained an injunction in an infringement suit on giving a bond for damages for wrongful injunction. To carry out its contract the paving company purchased the mixture necessary for paving one street from the patentee. The patent was subsequently held invalid in the infringement suit. The paving company then moved for damages under the bond, claiming the difference in cost of production by it and the price paid the patentee, haulage and minor items. A sum was allowed for this and decree entered therefor by the federal district court for eastern Missouri, 16 F (2d) 446. Both parties appealed. The Circuit Court of Appeals, Eighth Circuit, Western Willite Co. v. Trinidad Asphalt Mfg. Co., 32 F (2d) 487, holds that, the paving company being required by its contracts with the city to purchase the material from the patentee, irrespective of the validity of the patent, it could not recover damages on the bond, the only effect of the injunction having been to compel it to do just what it had agreed in the contract to do.

Highways for Access to Land

The Wisconsin Supreme Court, State v. Zubke, 227 N. W. 947, holds that section 80.13 of the state statutes gives a town board the power to lay out a public highway under that section only in cases where the applicants are unable to reach a public highway without going over lands owned by other persons. Highways laid out under this section are ways of necessity established to give those who are entirely shut off from a public highway access to the same.

Sufficient Claim to Contractor's Surety

The Ohio Supreme Court holds, Southern Surety Co. v. Schmidt, 117 Ohio St. 28, 158 N. E. 1, that where the improvement is the construction of a public highway under contract with the director of highways, the use thereof by the public for purposes of travel, without the official approval thereof by the state highway commissioner or some duly authorized agent of such commissioner, before the acceptance thereof, does not amount to an "acceptance" within the purview of the Ohio statute requiring the statement of a subcontractor or materialman to the contractor's surety to be furnished after the acceptance of the improvement by a duly authorized board or officer. The statement, it is held, need not be prepared with the particularity of detail required in a statement of account. It is sufficient if it advises the surety of the amount due and that it is for labor performed or material furnished in the construction for which the bond is given.

Time for Action to Enjoin Sale of Bonds

An action by taxpayers to enjoin the sale of bonds voted to construct a public utility in an incorporated town in Oklahoma must be brought within 30 days after the approval of such bonds by the Attorney General as bond commissioner; otherwise, it is barred by the special statute of limitations in C. O. S. 1921, § 4284. Johnson v. Town Board of Trustees of Arnett, Oklahoma Supreme Court, 281 Pac. 777.

Reimbursement of Assessments for State Highways

Under chapter 225 of the Kansas Laws of 1929, relating to the construction, improvement and maintenance of a state highway system wherein provision is made for reimbursement to taxpayers of the assessments made upon their lands for roads in the state highway system, built under the benefit district plan, the state highway commission in making reimbursement is not authorized to pay interest on assessments made or on bonds issued for deferred payments of assessments payable in installments at fixed times. State v. State Highway Commission, Kansas Supreme Court, 281 Pac. 855.

Contract Price for Subgrading

The subgrading of a street in a city, and the preparation for curbing and guttering for paving, constitute part of the "construction" of a highway within Iowa Code 1927, § 11042, authorizing action against any person engaged in the construction of a highway in any county where the contract is to be performed. In a subcontractor's action for subgrading a street, the plaintiff contended defendant contractor promised to pay him 55 cents per superficial yard. Defendant's witness testified that the agreement was for 55 or 50 cents per cubic yard, and that the agreement was with the witness, another subcontractor. The evidence therefore raised two questions (1) whether it was defendant or the subcontractor who made the contract with plaintiff; and (2) whether the price agreed upon was 55 cents per superficial yard or 50 or 55 cents per cubic yard. On the latter question it was held that evidence of reasonable and ordinary compensation for such work should have been received as bearing on the probability as to whether the price agreed upon was the one rate or theother. Goben v. Aken, Iowa Supreme Court, 227 N. W. 400.

Contractor Widening Street Not Liable for Sidewalk Injury

Actions were brought against a town and a contractor who had a contract with the town to widen a street for injuries sustained by the plaintiff in falling in a hole caused by the removal of curbstones on the westerly sidewalk of the street. In the action against the town it was held that, as it knew repair work was going on at the place of the accident, the responsibility rested on it to see that the way was reasonably safe. In the action against the contractor it appeared that another contractor had a contract with the town to remove the curbstones in the street. There was no evidence of defendant contractor's negligence. He did not remove the curbstones; he did not undertake the duty of keeping the sidewalk safe for travel; and there was evidence that he exercised no supervision over the contractor who did remove the curbstones. Plaintiff could not recover against the defendant contractor because of a clause in his contract with the town to the effect that he was to keep the westerly sidewalk open and safe for travel at all times. The plaintiff was not a party to this contract. Defendant had not undertaken the work of repairing the sidewalk and keeping it open and safe for travel.

Bond Construed by Laws of State Where Work Performed

The Circuit Court of Appeals, Fifth Circuit, holds, Federal Surety Co., v. City of Staunton, 29 F (2d) 9, that, where a public works contract and bond were entered into and were to have effect in the state of Illinois, where the work was to be performed, the rights of the parties must be controlled by the laws of that state. When furnishers of materials or labor came to deal with the contractor, and were acquainted with the nature of the contract and bond, the condition of which was that the principal obligor should make prompt payment to all persons furnishing labor or materials in the prosecution of the work provided for in the contract, they had a right to assume that they would have the benefit of protection under the bond, in view of the declaration of law to that effect by the Illinois courts.

Bond Protects Materialmen Furnishing Stone to Subcontractor

The Pennsylvania Supreme Court holds, Lower Merion Township School District v. Evans, 295 Pa. 280, 145 Atl. 288, holds that, under the Pennsylvania statute covering "labor and material entering into" the work, and a bond thereunder covering labor and material "furnished, done, performed or supplied, in or about the said building or work," there was no limitation in the bond or statute regarding the right to recover, except that the suit must be for "labor and materials entering into the building," and such a bond, given for the construction of a school building, was not limited to those who contracted with the builder for the furnishing of labor and materials, but included those who supplied stone to a subcontractor, which was used in the building.

Cost of Storm Sewers in Paving Improvement

Where nothing is said in a petition by property owners for the grading and paving of a street respecting the way the work shall be done, the Pennsylvania Supreme Court holds, Ashcom v. Borough of Westmont, 148 Atl. 112, that a borough council has the right to assume that the petition intended it should exercise its own judgment, within the scope of its statutory powers, regarding the manner of doing the grading and paving. Under a statute authorizing the borough to provide for the "necessary drainage" of the streets, the borough could provide storm sewers necessary to take care of the surface water properly. Where this work was substantially performed under the plans and specifications, the abutting owners were liable for the cost of the work done in front of their properties, including that of the storm sewers.

Trespass for Putting Dirt on Owner's Land

Even if the city had authorized or directed a trespass by a sewer contractor by putting dirt on an adjoining owner's land, such authorization or direction, the Kansas City (Mo.) Court of Appeals holds, Hyre v. Becker, 18 S. W. (2d) 137, would be no defense to an action for damages for trespass against the contractor, there being no evidence that the act was necessary as incident to the digging of the ditch.

Hired Teamsters Held Road Contractor's Employees

Teamsters hiring out with their teams to road contractors, and working as laborers and teamsters under the supervision of a superintendent, and who were paid in yardage, were held employees of the road contractor and not independent contractors under the Utah Workmen's Compensation Act. Columbia Casualty Co. v. Industrial Commission of Utah, Utah Supreme Court, 281 Pac. 198.

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IN Massachusetts, where severe climatic conditions plus rapidly-increasing heavy traffic would logically bring increasing road depreciation, maintenance costs of asphalt macadam and asphaltic concrete have actually *decreased* from year to year.

In 1927 the maintenance cost for 7,287,904 square yards of asphalt macadam there was 2¢ per square yard; in 1928 this decreased to 1.6¢; in 1929 to 1.4¢. Similarly for 2,749,951 square yards of asphaltic concrete, the decreasing maintenance figures were: Per square yard, 1.3¢ in 1927; 1.2¢ in 1928 and only 0.9¢ in 1929.

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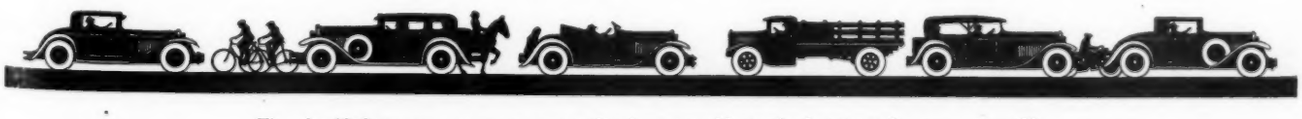

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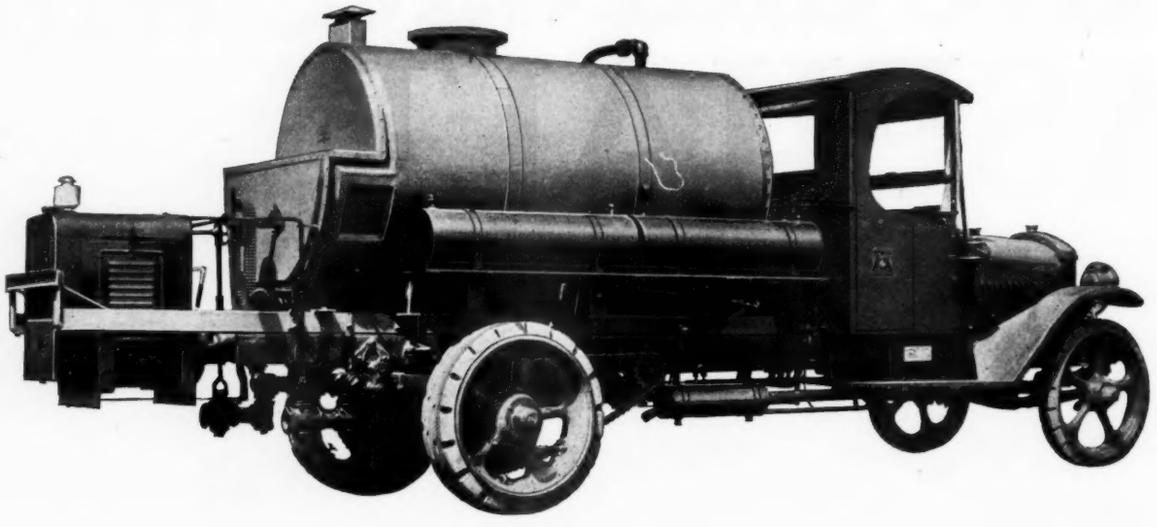

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Sewage Treatment at Gilroy, Calif.

GILROY, CALIF., with a population of 4,000, has been operating, since January 1929, a sewage treatment plant in which separate sludge digestion is preceded by a coarse bar screen with 1-inch openings and a Dorr traction clarifier 30 feet diameter from which the scum is skimmed automatically and is pumped, with the collected sludge, to the digester every 2½ hours. The effluent from the clarifier is disposed of by irrigation on a farm of 196.64 acres.

A cannery of tomatoes, peaches, spinach, apricots and peas handles 125 tons of fruit daily during the peach season, each ton of which yields 0.6 cubic foot of sludge, the total being equivalent to the sludge from 15,000 people, or nearly four times the population. This is said to be the first separate sludge digestion plant in California to handle cannery waste, and this process was adopted because of the large amount of sludge to be handled during certain seasons and the flexibility it offered. By adding a gas collecting and heating system the capacity of the digester can be increased.

Sixty acres of the farm is underlaid with 44,000 feet of 4-inch tile placed at an average depth of 4.5 feet in lines 60 feet apart. It is divided into beds and the effluent run onto one of these for two weeks, then diverted to another, each bed being used but once a year.

An analysis was made of the operation of the tank, samples being drawn from near the center by means of a pitcher pump with the following results:

Sample of	Depth Below Surface	Physical Appearance	Temp. (Deg. C.)	P.	H.	H_2S	Sol. %	Org. %	B. O. D. 1% Org.	Fats % Org.
Raw sludge	....	Gray	11.5	..	.		2.1	78.7	5,230	12.6
Influent	....	Not unusual	11.0	7.0	0		..	...	....	...
Effluent	....	Well clarified	10.5	7.1	0		..	...	....	...
Liquor		Cloudy, no odor	..	6.6	0		..	...	....	...
Sludge	19.08	Brownish, dark	..	6.8	?		4.34	51.44	1,680	8.2
Sludge	21.08	Homogeneous	..		?		4.4	52.2	1,690	9.6
Sludge	24.75	.....	9.5	6.8	.		4.7	59.4	1,460	10.4

The digestion appeared to be good, there was no offensive odor and little gassing or scum. The sludge was watery.

The digested sludge analyzed as follows:

Nitrogen, total	2.24%
Nitrogen, calc. ammonia	2.85%
Phosphoric acid (P_2O_5) total	3.50%
Potash	.22%
Phosphoric acid, available	2.61%
Organic matter	58.17%

A contract was made to sell all the sludge for $20 a ton at the sludge bed, estimated to yield $600 a year.

The land cost $3.7 000, and a rental of $1,910 a year is obtained, $556 from a seed company for 37.09 acres; $1234 for 126.21 acres as pasture, and $120 for a garbage dump; a total of over 5 per cent of the cost.

Construction of the plant cost $28,235. Operation of it for the year ending June 1930, cost as follows:

Electricity (at rate of 3½c per k.w.h. first 450, and 2.2c per k.w.h. over 450	$ 369.22
Operator (part time work)	696.00
Oil, grease and supplies	19.20
Total	$1,084.42

If 10 per cent of the cost of plant be added, it gives a total of $3,908; and deducting $600 for sale of sludge leaves $3,300 net cost. The cost per capita or per million gallons of sewage means little, considering that the cannery wastes contribute more solids than the domestic sewage, and are responsible for probably three-fourths of the cost of the plant.

Location of Airports

From the viewpoint of city planning. Grading, drainage and soil characteristics.

The Department of Commerce, in a recent bulletin, discusses the subject of locating airports at some length, and from various viewpoints. From that of city planning it says:

"The location of an airport in a given area will naturally stimulate the growth of that section and will tend to attract building operations of various kinds, some of which will be detrimental from the point of view of safe operations from the airport. It is important that suitable steps be taken to protect air terminals against developments that might tend to jeopardize the safety of the flying public and otherwise reduce the effectiveness of the airport. In an effort to meet the many requests that are being received from city officials and others interested in this matter and desiring information on the subject, the Aeronautics Branch of the U. S. Dept. of Commerce has organized a committee on airport zoning and eminent domain to make a comprehensive study of the subject and submit a report setting forth its findings and recommendations. It is expected that this report will be forthcoming during the late fall.

"Most airports are either in the process of development at the present time or are so new that very little attempt has been made to beautify them by landscaping and making them part of the cities' park and boulevard system. However, it may be expected that increasing consideration will be given to this matter as the work on the purely utilitarian part of the airport approaches completion."

In comparing costs of different proposed sites, the article stresses the importance of including not only purchase price but also the expenditures necessary for clearing, grubbing, grading, draining and surfacing. Concerning drainage it says:

"It is essential that the airport be usable throughout all weather conditions. If the soil on the site selected for airport development does not possess sufficient self-draining characteristics to insure the safety of all-weather operation such supplementary artificial draining should be installed as is necessary to secure this end.

"The landing area should be graded so that it presents a smooth uniform surface with a mean slope of not in excess of 2 per cent and a grade break at any point not in excess of 2½ per cent. In planning the grading of the airport it is well to consider taking care of surface run-off, in addition to meeting grade requirements since such planning usually simplifies drainage problems.

"An item which often receives too little consideration in selecting a site is the matter of soil characteristics. By a proper selection of a site with this point in view it is possible materially to reduce the expenditure necessary for draining and surfacing. The most desirable type soil for airport purposes is one containing a reasonable amount of porous material such as gravel, or decomposed granite, combined, of course, with a suitable natural binder. The undesirable types are the soils which become plastic and have a low-bearing power when wet. The nature of the subsoil should be investigated since the effectiveness of

a porous topsoil is materially reduced if there is an impervious subsoil located very close to the surface. On the other hand, the fact that there is a gravel subsoil underlying a shallow clay topsoil materially alters the situation over what it would be if the clay topsoil extended down a considerable depth."

Culvert Pipe for State Highways

(Continued from page 52)

Arizona and Washington test cast specimens of concrete. The A. S. T. M. test methods are specified by one state for cast iron and by five for vitrified clay.

Strength requirements are expressed in terms of the diameter of the pipe in all states for all kinds of pipe, except for vitrified clay pipe in California which is expressed in pounds, and the cast concrete specimens in Arizona and Washington.

In general the strength requirement of a given state is the same for all kinds of pipe. It is 1500 D in Illinois, Kansas, Louisiana, Maine, Maryland, New Hampshire, North Carolina, South Dakota, Texas and West Virginia. It is 1800 D in Mississippi; and 2000 D in Colorado and Georgia.

1800 D is used for cast iron and reinforced concrete, and 1200 and 1800 for vitrified clay in Alabama. Florida uses 1800 for cast iron and reinforced concrete and 1500 for vitrified clay. Ohio uses 2000 for cast iron and reinforced concrete and 1500 for vitrified clay. Vermont uses 1500 for cast iron and 2000 for reinforced concrete. Wisconsin uses 1500 for cast iron and vitrified clay, and 2000 for reinforced concrete.

Of states not specifying tests for all three materials, Nebraska, North Dakota and South Carolina use 1500 for vitrified clay and concrete; Arkansas uses 1600 for vitrified clay and 2400 for reinforced concrete; Indiana, 1800 for clay and 1500 for concrete. Several states specify two strength requirements, one for larger and the other for smaller pipe. For cast iron Connecticut and Massachusetts use 1500 and 2000; Virginia uses 2000 and 3000 and Iowa 2000 and 4000. For vitrified clay, Alabama uses 1200 and 1800; Kentucky uses 1500 and 2000; Tennessee uses 1250 and 1800; and Iowa 2000 and 4000. For reinforced concrete, Connecticut, Delaware, Kentucky, Minnesota, Montana and New Jersey use 1500 for 24″ pipe and larger and 2000 for pipe smaller than 24″; California and Iowa use 2000 and 4000.

For strength requirements, the A. S. T. M. specifications are used by Connecticut, Delaware, Massachusetts and New York for vitrified clay pipe, and by Michigan for this and for cast iron also. For reinforced concrete, Massachusetts and New York use the specifications of the Joint Concrete Culvert Pipe Commission.

Small Town Averts Water Shortage

(Continued from page 27)

11 feet but this has gradually recovered so that it stood at 8 feet when the writer visited the well after it had been in service about 36 hours. It is estimated that the pump is discharging about 75 gallons per minute. Due to friction losses in the 2 and 1½ pipe, part of the 2-inch is to be replaced with 3 inch and the 1½ inch with 2 inch. With the elimination of part of this friction it is thought there will be no difficulty in putting water in the standpipes.

The bacteriological quality of this water was not known therefore the chlorinator from the filtration plant was moved to the well. It is a Wallace and Tiernan type MSP machine with a bubble meter. Water for operating the injector is taken from the discharge main at the pump. The hose carrying the chlorine solution was dropped into the well a distance of 37 feet, putting it well below the foot valve. The chlorine dosage was set at double the quantity used for treating the impounded supply but no orthotolidine reaction was obtained. The quantity was increased nearly to the capacity of the bubble meter before a reaction was observed. The chlorine demand of this water is very high, due to the iron content. It is of interest to know that the water taken from a tap in the city before the chlorine dosage was increased had a distinctly iron taste and was most unpalatable, particularly to one not used to drinking waters containing high iron; but the taste of the water taken directly from the well after the dosage was increased was not at all unpleasant—in fact, the writer liked it very much. It is possible that, due to the warm day, drinking a large quantity of this water dulled the taste; however, it is believed chlorine reaction with the iron was responsible for it.

In order that the filtration plant can be operated whenever there is a sufficient quantity of water in the reservoir and without having to move the chlorinator from the well until all danger is passed, a Wallace and Tiernan emergency chlorinator of the main sterilizing type was shipped to LaFollette from the State Department of Health and installed at the filtration plant.

There is every reason to believe that the situation is satisfactory now and that no further danger from a serious water shortage exists.

Economics of Highway Design

(Continued from page 34)

compacted by traffic, the gumbo subgrade is bladed smooth and road oil applied hot at the rate of ⅓ to ½ gallon per square yard. This application is allowed to penetrate into the subgrade and is followed by a second application of oil at the rate of about ⅓ gallon per square yard. The gravel for blotter has previously been placed in windrows along one shoulder and immediately after the second application of oil this gravel is pulled over the oiled surface with a rubber-tired power blader. This gravel should all pass a ½-inch screen and best results have been obtained from applications of 350 to 500 cubic yards per mile. During maintenance, this thin gravel blotter is moved back and forth over the road surface and during the second year another application of oil is made at the rate of about ¼ gallon per square yard, and additional gravel applied at the rate of about 150 cubic yards per mile. This type of surfacing is being used in place of the usual 8-inch gravel construction and is proving far superior as to riding qualities, and much more economical both in first cost and upkeep. So far as present research has gone, this particular treatment is only applicable to heavy clay soils of the gumbo class.

Traffic-Bound Macadam—Another development in low-cost road building which is rapidly gaining favor is the traffic-bound macadam. This is in reality a subgrade stabilizer and road surfacing combined. The granular material used for the first course is driven into the subgrade and supplies the necessary internal friction to provide beam strength to support the traffic load transmitted through the wearing course. The material used for this treatment may be slag, scoria,

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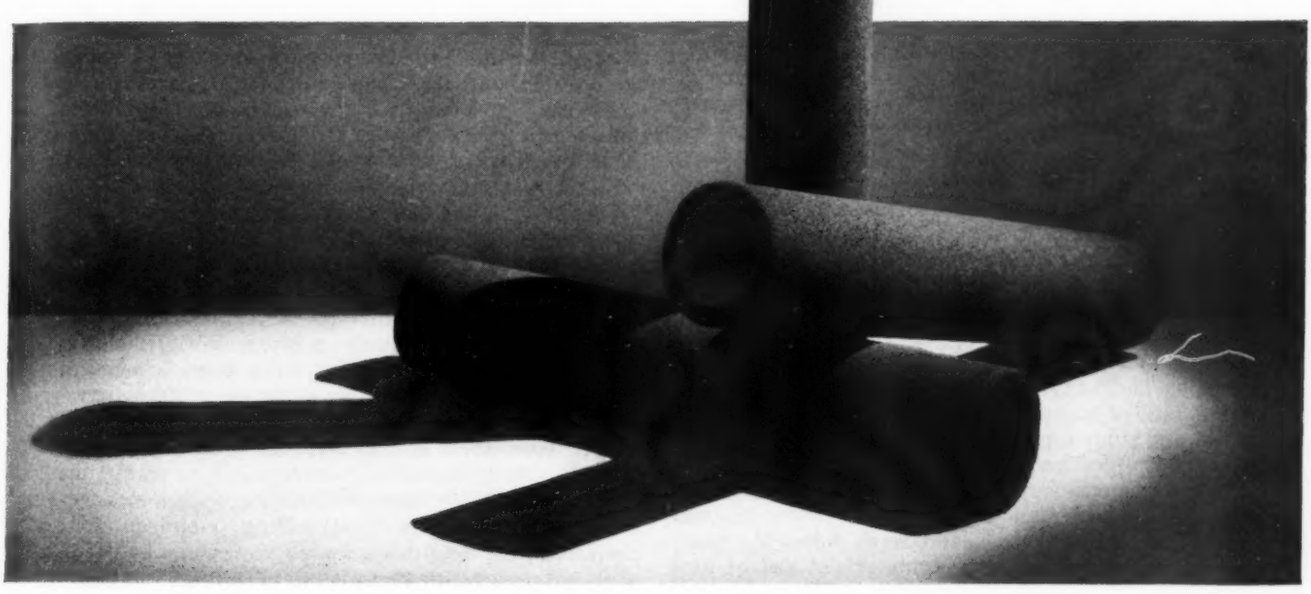

Norton Porous Tubes

REMINGTON, Vosbury & Goff of Camden, New Jersey, engineers who laid out the plans for the new sewage disposal plant in Woonsocket, Rhode Island, were much impressed with the service given by Norton Porous Tubes for aeration in several eastern disposal plants.

For this reason Norton Porous Tubes have been specified and are being built for installation in the new plant which will soon be in operation.

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cinders, crushed stone or gravel, of a size that will pass a one-inch ring and contain from 10 to 25 per cent material passing a quarter-inch screen. After the earth subgrade has been shaped up and somewhat compacted by traffic, this granular material is spread evenly over the road in a thin layer from 1½ inches to 3 inches in thickness. The road is then opened to traffic and kept smooth by blade grader manipulation until the material has been driven into the subgrade. Additional layers are applied successively and similarly manipulated and compacted by traffic until a stable crust has been produced which can be oil treated or used as a foundation for a bituminous surface course. This type of construction is being used to a great extent in Kentucky, Tennessee, West Virginia, Virginia, Nebraska and Kansas.

Mixed-in-Place—Another low-cost road surface type, not seen in the New England States but used on hundreds of miles of western roads, is the mixed-in-place bituminous treatment. This treatment has been applied successfully to old gravel and crushed stone roads which have become badly raveled and dusty, and also to the upper layer of newly laid surfacing material. The gravel or crushed stone is first scarified to a depth of about 3 inches and bladed to a true surface. Light oil is then spread over the road at the rate of about ½ gallon per square yard and the oil and stone mixed together by means of harrows. Another application of oil at the rate of about ½ gallon per square yard is made and the surface again harrowed. The blade grader then turns the oil and stone over and over, back and forth across the road, until the materials are thoroughly mixed and of uniform color. During this processing operation more oil is added if necessary, and then the whole mass is bladed into position and opened to traffic. During compaction, a blade grader is operated continuously to keep the surface smooth and free from ruts. These oil processed roads are relatively inexpensive and possess very smooth riding qualities.

Retread—A somewhat similar process being used to considerable extent in the central States is designated "retread." In this process a cut back asphalt is used instead of the fuel oil commonly used in the west, and the aggregate is somewhat coarser. This retread work is common in Indiana, Tennessee, West Virginia and Pennsylvania. The emulsified asphalts have also been tried with some success in the mixed-in-place treatments in California, Washington and Oregon.

Heavy-Traffic Pavements

Cement Concrete—In the heavy-traffic pavements the cement concrete type appears to receive the most attention from the research specialists and testing engineers. Volumetric proportioning of aggregate is no longer considered sufficiently adequate control, and proportioning by weight is becoming standard practice. It has also been found that a considerable saving in cost may be made by more scientific grading of the aggregate and combining the sizes in proportions which will produce the maximum practicable density and relatively low cement factor without seriously reducing the strength of the concrete. On some projects the cement factor has been reduced to 1¼ barrels to the cubic yard, while still maintaining 3500 pound concrete.

This present trend in designing mixes with the lowest possible cement factor is not looked upon with favor by some highway engineers. If strength is the only factor to be considered, and the present strength test is a true indication of the slab strength, then the present trend would seem to be in the right direction; but there are many engineers who believe that durability is being sacrificed in these low cement factor concretes, and there is some doubt whether the strength tests of carefully molded cylinders and beams made by laboratory methods is a true indication of the strength of the pavement slab laid and finished by machine methods with practically no tamping or spading. There are some indications that these harsh mixes are producing honeycomb concrete, and it is doubtful if such concrete is as resistant to destruction by the elements as the richer mixes of a few years ago. It will probably take several years to determine whether the low cement factor concretes of today are durable, and until more information is available on the subject it might be well to keep a slight factor of safety by adopting a reasonable minimum cement factor such as 1.4 or 1.5 barrels to the cubic yard.

During the past two years, there has been considerable study of the use of special cements which produce high early strength concrete. The use of these special cements has been principally in the construction of highway intersections, industrial drives, repairs to busy streets and on bridge floors, but it is beginning to be realized that there is an economical advantage in using such cements in regular pavement construction where detours are difficult to arrange. With these special cements, sufficient strength may develop in from one to three days to permit the road to be thrown open to traffic, and this means a tremendous saving to the traveling public on those projects where long detours would otherwise be necessary for periods of 14 to 21 days. At 10 cents per mile per vehicle, a detour 4 miles long with a total traffic of 2,500 vehicles a day will cost the vehicle owners $1,000 per day, a sum sufficient to purchase the special cement for an average day's run of pavement.

During the past two years, considerable study has been given to the curing of concrete pavements by water substitutes. The materials tried out for this purpose are calcium chloride, sodium silicate, asphalt and tar cut backs and emulsions, wet burlap and various fibrous materials. The data from numerous experiments in all sections of the country are somewhat conflicting, and further study will be necessary on this problem.

In the design of concrete pavements there is still such a lack of uniformity that it is diffiult to state what is considered standard practice. The thickening of the edge of the slab is almost universal practice, although a few States still use the uniform thickness design. In designing the thickened edge slabs, most States use the Clifford Older formula,

$$D = \sqrt{\frac{3W}{S}}$$

Where D is the edge thickness
W is the wheel load in pounds
S is the maximum allowable fibre stress in pounds per square inch.

For balanced design, the center thickness should be 0.7 of the edge thickness. The maximum wheel loads permitted by law in the various States range from 6,000 to 11,000 pounds. To allow a margin of safety for taking care of factors which affect the stress, but whose influences can not be accurately estimated, it is customary to use a working stress S equal to one-half the ultimate bending strength or modulus of rupture. For most mixes this working stress will

(Continued on page 69)

be 300 to 350 pounds per square inch for 28-day concrete, and the pavement thicknesses designed from this formula will range from 10-7-10 inches to 8-6-8 inches, depending on values of W and S, and on the approximations permitted.

The longitudinal joint is almost universal practice, but the method of transferring the stress across the joint varies considerably in the several States. The majority of States use expansion joints, but the spacing varies all the way from 20 feet to 200 feet, and twelve States use no expansion joints at all. Many of the differences in design may be attributed to local conditions, but admittedly there should not be the wide differences which now exist.

Bituminous Concrete—In the construction of bituminous concrete pavements, considerable study has been given to the use of low-cost aggregates which have not heretofore been considered suitable for this type of surfacing. Progress has been made in the adaptation of mechanical spreaders and finishers for bituminous concrete construction, and the riding qualities have been improved and the cost of construction reduced by means of these devices.

Cold-laid bituminous mixtures are gaining in favor, and may become as popular in this country as they have been for many years in England. One of the chief advantages of the cold-laid types of surfacing is the fact that no elaborate plant is necessary on the job. The aggregate and bituminous materials are mixed at a central plant, shipped to the job in cars or trucks, dumped on the road, and spread and rolled with very little interference to traffic.

One of the novel features brought out by the cold-laid types has been the use of asphalt in pulverized form instead of liquid. One type provides for coating the aggregate at the central plant with pulverized hard asphalt and soft fluxing asphalt which remain unblended until reheated at the job. In another type the cold, dry aggregate is first coated with the fluxing oil, then with the powdered asphalt and then transported to the job and laid cold. In still another type the powdered asphalt and oil flux are heated and blended before mixing with the aggregate. Cold-laid types that do not use the powdered asphalt use asphalt emulsions, asphalt cutbacks or asphalt cement with liquefier.

Brick—In the construction of brick pavements the two outstanding recent developments have been the introduction of the thin brick and the utilization of the mastic cushion as a substitute for the sand or sand-cement cushion. The tests by the Bureau of Public Roads at Arlington have demonstrated that 2½-inch brick may safely and successfully be used for heavy traffic, and a decided economic saving is possible through the use of such brick in place of the usual 3-inch and 4-inch sizes. The mastic cushion is composed of sand mixed with 7% to 11% bitumen, and its chief advantage lies in its ability to bridge open joints and cracks in the base into which the usual sand cushion would flow.

Grade Crossings

One of the greatest hazards and source of economic waste on our highways today is the railroad grade crossing. The 1928 report of the United States Interstate Commerce Commission shows 2,568 killed and 6,666 injured at crossings, mostly in automobile accidents. In addition to this serious loss of life, there is a material loss of time to vehicle users through retarded speed and in waiting for trains to pass. Studies made in the Cleveland regional traffic survey showed total vehicle time lost at crossings from 12 to 46 hours per day.

As a method of determining the priority of grade crossing eliminations it has been suggested that an economic time study be made at all crossings and list them according to their relative obstruction to free flow of traffic. The value of the time lost by vehicles capitalized at 6% would indicate the justifiable expenditure from public funds to eliminate the grades. Another suggested method of determining priority of grade crossing eliminations is to evaluate the various elements of danger to human life at each crossing, such as number and speed of trains, number of tracks, number of vehicles, sight distance, grade and angle of the approach highways, and the effectiveness of the protective devices. The disadvantage of this method of programming elimination lies in the fact that the elements to be evaluated are not readily measurable and for this reason the economic loss method is looked upon with more favor by engineers.

The volume of traffic is now so great on main line highways near large cities that separation of grades at highway intersections is becoming more and more necessary. The expense of such grade separations is heavy but the increased safety to traffic and the increased capacity of the highway may fully justify the expense because otherwise additional traffic lanes would be required to give the same flow of traffic. To give access to the intersecting roads, short connections on all four sides should be provided and traffic so routed that all turns are to the right with no crossing of lines of traffic. Where grade separations are not feasible, best results at highway intersections appear to be obtained where the intersecting pavements are widened by extra lanes on each side for a distance of 300 to 500 feet back from the intersection.

Barrington Sewage Treatment Plant

(Continued from page 22)

Adjacent to one end of the sludge digestion tank are two rising wells each 2 ft. 6 in. square and 18 ft. deep, one of which receives the sludge from the clarification tank and the other the activated sludge from the final settling tank. Sludge is lifted from each of these through a 6 in. vertical sludge pipe by means of air lift, and discharged into a concrete distributing box placed on the sludge digestion tank roof. In one compartment of the distributing box the activated sludge is separated, part of it (reaerated at this point, if necessary, by means of a 1¼ in. brass perforated air pipe) being carried to the incoming raw sewage, while the rest flows into the sludge digestion tank. The sludge returned to the raw sewage passes over three notch weirs 4 inches high, measuring the amount carried through each of the three aeration channels.

Gas Utilization

The eight domes which collect the gas from the sludge digestion tanks are oil sealed and are connected by means of a 1½ in. wrought iron pipe to a 6 in. condensation trap, consisting of a 6 in. wrought iron pipe capped at the lower end, while the upper end is provided with a sixteen-mesh copper screen. Gas entering this trap passes through the screen into a 300 cu. ft. per hour gas meter. From the bottom of trap a 1 in. blow-off line permits removing any moisture collected there.

From the meter, the gas passes through a pressure

relief trap 24 in. diameter by 48 in. high set vertically, with a 2 in. pipe extending down approximately 10 in. from the bottom, where it is sealed with water; which trap operates only if the pressure of the gas becomes too great. The gas then enters a fire trap placed outside the boiler room roof and consisting of a 30 in. cast-iron pipe about 24 in. long, the bottom covered with a solid plate and the top with a plate carrying a 12 in. hole in which is fastened a vertical 12 in. pipe 12 in. long, at the top of which is a paper diaphragm protected from weather by a galvanized steel hood. Should flame back up in the burners, the gas in this fire trap would explode, breaking the paper and releasing the gas into the atmosphere. The gas enters this trap through a perforated copper coil in the bottom thereof, so that the flame could not follow back into the supply line.

The gas then passes to a Bryant hot water boiler having a rated capacity of 720 sq. ft. As the temperature of the water rises and falls in the supply line, a quick-action valve on the gas line opens and closes, regulating the supply of gas to the burners. Gas is also piped to another Bryant heater to supply heat to the radiators in the filter building. The hot water used to heat the digestion tank passes through the heating coils in it already referred to and from them is brought back to the boiler room, being circulated by a 15 g. p. m. pump.

Sludge Drying Beds

For sludge drying there are six compartments or beds, each with an area of approximately 500 sq. ft. The floor of each bed slopes toward a 12 by 12 in. trench in the ground running lengthwise of the bed, in the bottom of which is a 6 in. vitrified pipe with open joints wrapped with muslin to prevent the sand from entering. These pipes carry the drainage from the sludge to an 8 in. line, which discharges it into the wash-water storage well, from which it is returned to the grit chamber. The liquor decanted from the sludge digestion tank also is discharged into this drainage line.

The flume bringing the sludge from the digestion tank runs along the ends of the six beds, and six 8 in. shear gates are provided in this flume, one on the center line of each bed, and under each gate is a concrete splash plate. Hose connections are provided along the flume for flushing it after withdrawing sludge, to prevent the sludge caking in the flume.

In each bed are three layers of gravel, the first 1½ to ¾ in. in size, 3 in. deep at the upper end and 6 in. at the lower end of the bed; next 3 inches of ¾ to ⅜ in. and a third layer of ⅜ in. to ⅛ in. On top of this is 6 in. of sand with an effective size of 0.4 to 0.5 millimeters and a uniformity co-efficient of 3.50. All six beds are covered with a glass enclosure manufactured and installed by the Lord & Burnham Co.

Contact Tank

The contact tank, in which the chlorine is applied, is 20 ft. square inside and 10 ft. deep and is provided with round-about creosoted wooden baffles spaced 5 ft. apart. The effluent from the filters is discharged into one corner of this and treated with chlorine through a hard rubber diffuser pipe, then flows around the baffles into a 10 in. outlet pipe, which discharges into the stream on the upstream side of a concrete dam, several feet below the intake for the water supply system used at the plant.

This plant was designed by Remington, Vosbury and Goff, consulting engineers, of Camden, N. J. Contract was awarded in March, 1929, to Eugene F. Verga of Camden. The Roberts Filter Mfg. Company furnished and installed the mechanical equipment, exclusive of the sludge collectors and aerators, which were furnished by the Link-Belt Company of Philadelphia. The sewers are being laid by Albert Ellis of Moorestown, N. J. The total cost of the plant, including the sewer system, was approximately $330,000.

Road Location and Design for Snow Drift Prevention

(Continued from page 26)

vestment be justified? Or suppose that experience indicated that, in a given region, it were desirable to support the grade line an average of two feet above the general ground surface. Would still an additional $1,500 investment be justified? Such design will result in ditch sections of sufficient depth and width to meet all the requirements of drainage and provide ample snow storage as well.

In the Red River Valley and other situations in the state where flat or gently rolling slopes prevail, this method of design seems very effective in snow drift prevention. It involves an additional volume of grading with a somewhat higher first cost, but results in lower annual charges per mile of highway when all factors such as snow fencing, drift removal, extra maintenance cost to traffic, etc., are taken into account.

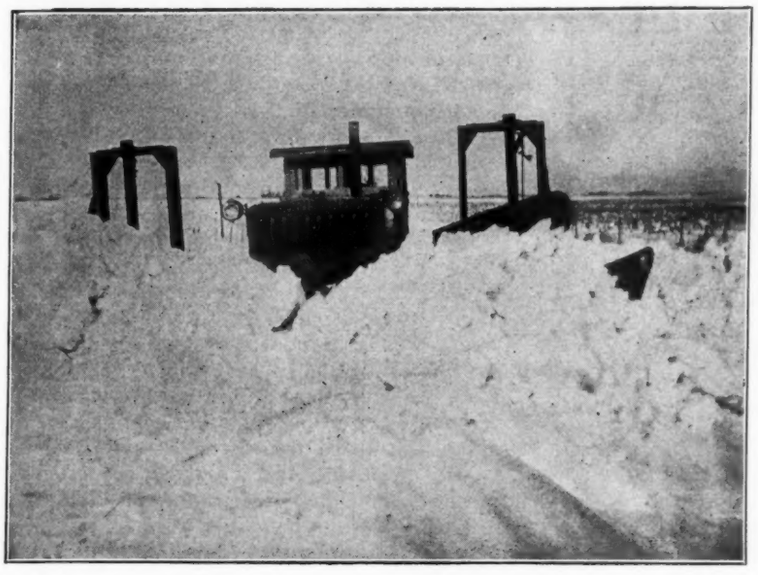
This principle of supporting the grade line well above the general surrounding natural surface of the ground can be applied in more rolling topography as well. Under these conditions, however, it brings into the picture a number of controversial subjects; rolling grades versus tangent grades; fills from borrow against fills from cuts; short vertical curves to fit topography, opposed to long vertical curves to provide adequate sight distance; and so on.

Assuming that the principles of rolling grades were acceptable, it is apparent that in topography where the natural slopes did not exceed the maximum grades being used, a rather effective job of snow drift prevention could be accomplished. Even in situations where natural slopes somewhat exceed the maximum grades being used, similar results could be obtained by greater use of borrow material to build up fills.

When, however, the topography involves steeper slopes and the requirements of grade result in a series of cuts and fills, snow drift prevention by elevation of grade line above the natural ground surface becomes impracticable. It is these conditions that prevail over the largest portions of an average system of highways. The question of keeping the road open is largely one of keeping the cuts open, for a cut is an ideal place for the formation of a drift. It resolves itself into a problem of so designing a cut as to eliminate or minimize the effects of drifting snow.

At this point it seems appropriate to state the ideals to be striven for in location and design of roads for drift prevention. The object is not to eliminate the necessity for snow removal, for this would be impracticable, since falling snow, entirely free from the effects of wind, might accumulate to such depth on the roadway as to require removal. Rather the aim is to prevent the formation of drifts of greater depth and length than can be sufficiently handled by light, high-speed snow plowing units. In the language of maintenance men, this commonly means modern trucks of 2½ to 4 tons capacity, equipped with the necessary plows and wings.

Experience accumulated up to the present time



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points to such units as the economical ones to use on account of their adapability to all-the-year maintenance. In the annually recurring combat with the snows, they form the first line of action. When the arteries of highway transportation are threatened with blockade, they sally forth from their bases of operation and, provided the drifts are not too deep and long, proceed with speed and dispatch to "open up." If they are able without the assistance of heavier equipment to cope with the situation, no time is lost and traffic suffers but little delay. If heavy, slow-moving units, such as tractors, special heavy trucks, rotaries, etc., are required for the initial opening up, then days may elapse before roads are restored to service. In our modern life, the normal flow of business is so vitally dependent on highway transportation that any interruption is serious in its consequences.

It is desirable, therefore, to design cuts so that no drifts will form deeper or larger than can be handled by light, high-speed units on the first run after a storm. It is easy to observe that a narrow cut will drift full in much shorter time than a wider one. The wider cut will require a storm of longer duration or greater intensity before filling up. This is due to a difference in snow storage capacity. Snow storage is wanted to take care of drifting snow and also to take care of snow which is plowed and pushed off the roadway. The former is most effectively obtained by widening the cuts on the windward side; the latter by providing deep, wide ditches.

After a ditch of sufficient depth and width to provide storage on the leeward side for snow plowed and pushed off the roadway, then all additional widening should be on the windward side. Assuming a cut three feet in depth with respect to the road surface, what width of ditch will be necessary to prevent formation of a drift? A natural snow slope is a variable, of course, depending on the velocity of the winds. A ten-to-one slope might be assumed for average conditions. Then, if the top of cut is thirty feet from the nearest edge of roadway, this will define a ten-to-one slope, and should be rather effective in drift prevention. If the top of cut is fifteen feet from the nearest shoulder, a ten-to-one slope will extend to the center of a thirty foot roadway.

As a matter of fact, this three-foot cut will in effect become a four-foot cut after a foot of snow has accumulated on the ground surface. The foregoing is on the assumption that the direction of the wind is normal to the centerline of the road. Suppose, in the example given above, that the road is east and west, that the grade is level, and that the direction of wind is from north forty-five degrees west. Then, if the top of cut is twenty-one feet from edge of roadway, a line coincident with the direction of wind, and drawn from top of cut to edge of shoulder, will define a ten-to-one slope.

Suppose we have a cut twenty feet in depth. It becomes apparent at once that it would never be economical to snow slope it. But this isn't necessary, for it may be thoroughly practical and economical to widen it sufficiently to provide ample storage for prevention of serious drifting on the roadway. It has also been observed in the case of deeper cuts that the action of the wind seems to induce air currents which have a tendency to sweep through the cut and to carry the snow along with them. The beneficial effect of such air currents in many cuts is very noticeable.

The question may be asked, "How much of this widening can be justified from an economical standpoint?" In the case of an important trunk highway

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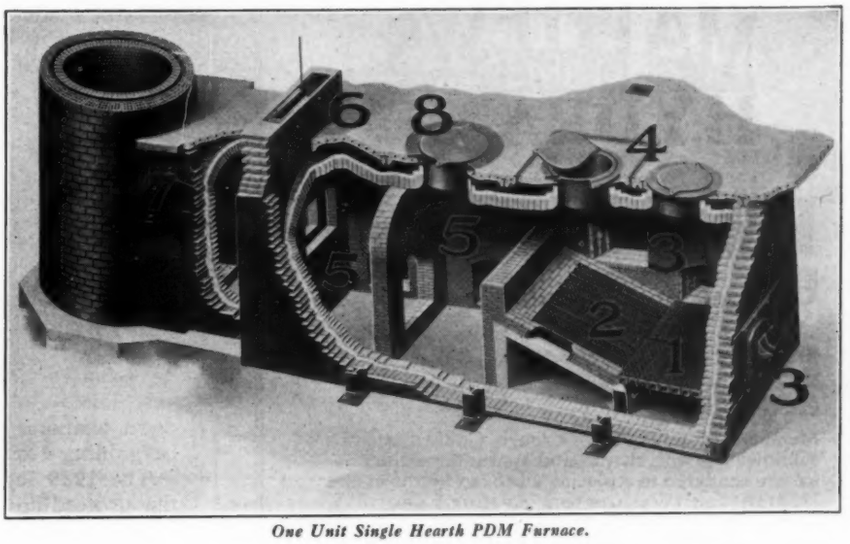

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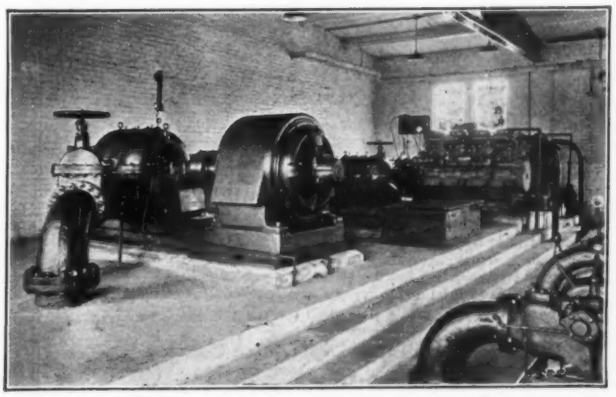

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June 9th, 1930

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GENTLEMEN:—

Members of Souderton Borough Council wish to acknowledge with thanks and appreciation the service you rendered in replacing a broken Mathews Fire Hydrant on Washington Avenue, Thursday, April 17th, 1930. This Hydrant was set in a new cement sidewalk on one of our finest concrete streets, and was struck by an automobile.

We thought we would have to break up the new sidewalk and concrete roadway to dig up the broken Hydrant. You can readily understand our great relief when we learned that by the use of your new Mathews Extraction Tool the broken barrel could be replaced without excavating.

We were agreeably surprised at the efficiency of this Extraction Tool. It enabled us to replace the broken barrel in less than an hour. This time included the repairing of the protection case, which was also broken at the upper end.

When the job was finished there was no indication that the Hydrant had been broken, because the sidewalk and the concrete street had not been disturbed or damaged. In addition to preserving the appearance of the new sidewalk and street, we saved a considerable sum of money.

We cannot express too strongly our entire satisfaction with Mathews Hydrants and the new Extraction Tool which made all this possible.

Yours truly,
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the answer is: "As much as is necessary in order that light, high-speed snow plowing units can open up without difficulty on the initial run after a storm." Anything less will cause serious interruption in the flow of traffic.

Minnesota design now provides for a minimum widening of forty-eight feet on each side of the center line in all cuts. For sake of illustration, suppose that, from maintenance headquarters as a base, it would be practical to map out an economical run of one hundred miles for a light, high-speed snow plowing unit—except for a few isolated cuts in which the drifts are ordinarily too heavy. How much of an expenditure could be justified for widening these cuts sufficiently to eliminate the heavy drifting? If it were necessary to assign a piece of heavy equipment to keep these cuts open, it seems that the cost could be capitalized at quite a sum.

Since 1923 it has been the practice in Minnesota when negotiating for right-of-way to stipulate that the state acquire and retain a snow fence easement. This confers the right to enter on the adjacent private lands for the purpose of creating and taking down temporary snow fence, without the necessity of bargaining each year with the owner for the privilege.

The 1929 legislature passed an act providing that the proceeding to acquire right-of-way includes this privilege without the necessity of special stipulation. This act provides that compensation for right-of-way includes damage, if any, for such erection of snow fence.

The provisions of this act are absolute with respect to acquisition of right-of-way on new location, but its application to widening of old right-of-way is not so clearly established, though its legality in this particular will soon be determined by a test case in the courts.

An adequate design is the brightest hope in the campaign for drift prevention and removal of snow.

Essentials of Engineering Contracts

(Continued from page 32)

in writing or oral orders should be confirmed in writing as soon as the extra work has started. Giving oral orders on the job easily becomes a habit and courts might construe the continual failure of an engineer to observe the provision for written orders as a waiver of it.

Liquidated Damages.—The parties to a contract may agree on a sum which they value a breach of contract and this sum may be written into the contract as "liquidated damages." The courts will recognize this, providing there is proof of the loss suffered. If the sum written into the contract is greater than the loss suffered, the sum may be regarded as a penalty and not enforceable as "liquidated damages." A penalty for delay, to be enforceable, should be accompanied by a bonus in like amount for completion ahead of schedule.

Engineer to Determine.—To minimize disputes and litigation arising out of a contract, provision should be made, in the absence of an arbitration clause, that the engineer make all determinations in relation to the work under the contract. In any case, the engineer should determine the quality of materials and the acceptability and fitness of the work and his determination should be final and conclusive and binding upon the contractor. Questions may arise out of unforeseen conditions, changes of plans, lack of information, which the courts are asked to decide. In such cases questions of fact are usually decided by a jury which

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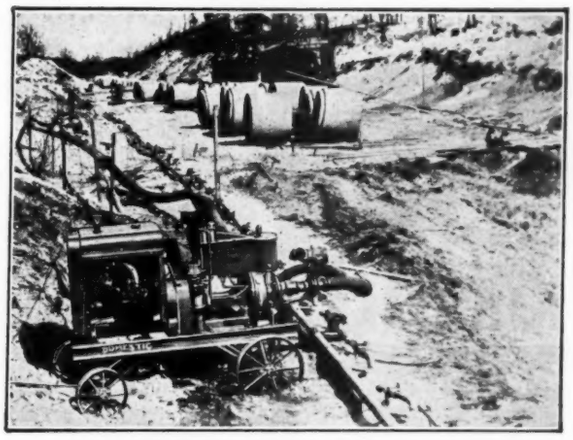

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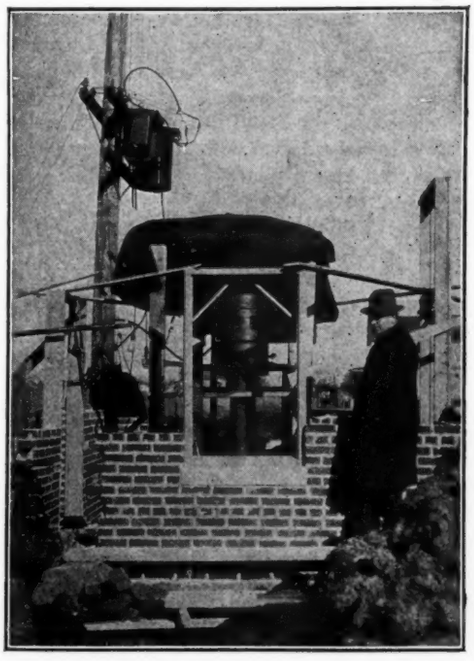

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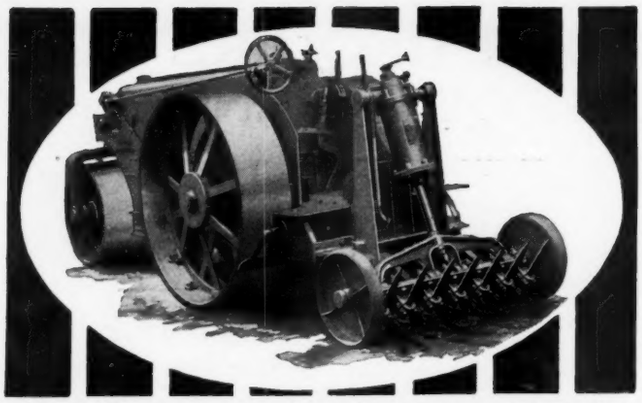

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may be made up of musicians, ribbon salesmen or what not who are often unable to understand the technical issues clearly enough to pass judgment and are therefore apt to be unduly swayed by the attorney's presentation of the case.

Arbitration.—It is desirable to have a clause in the contract by which the parties agree to refer matters of dispute to arbitration—not matters of the quality and acceptability of materials and work, which should be determined in all cases by the engineer, but other matters of dispute. Such a clause may be desirable, even in contracts for public work. Arbitration laws exist in New York State and in several other states, under which provision may be made for the settlement of disputes by a board of arbitration, the personnel of which is selected by the parties to the contract. The American Arbitration Association maintains a national panel of arbitrators of high calibre whose services are available to the parties upon request. Under the rules of the association, the arbitrators may serve without compensation, but the parties each pay to the association a fee varying from ten to twenty-five dollars, depending upon the amount of the claim.

There appears to be no legal objection to the inclusion of an arbitration clause in a public contract. The Port of New York Authority has such a clause in a number of its contracts. The Board of Water Supply of the city of Detroit has inserted arbitration clauses in five contracts involving some three million dollars of construction work. In Minnesota and Pennsylvania the local statutes specifically authorize governmental departments to insert arbitration clauses in construction contracts. It seems that the modern method of arbitration would improve the relations between the owner and contractor by permitting a free and frank discussion of their difficulties around the arbitration table rather than by the complicated and expensive procedure of the courts.

Bond.—The bond should be made in form provided in the contract for the sake of uniformity and so as to leave no chance for misunderstanding. The form of bond should be so drawn as to be effective after physical work under the contract has been completed so as to cover possible suits for damages which may be filed after the contractor has received his final estimate.

The amount of the bond for faithful performance should vary in accordance with the type and character of the work, but be sufficient together with the retained percentage to cover the probable cost to the owner incidental to default of the contractor. Premium rates are generally based upon the total cost of the work rather than upon the amount of the bond itself. The bond rates for subway construction contracts in New York City vary between certain limits in accordance with the proportion that the amount of the bond bears to the total cost. In other cities the amount of the bond varies between five and two hundred per cent of the total contract cost. In the states of Iowa and Georgia, the law requires the bond to be in an amount equal to the full amount of the contract.

Proposal.—The proposal is an offer or promise which, when accepted, becomes in itself a legal contract. It should form part of the whole contract and be in accordance with its terms. A certified check as security against default of the bidder should accompany the proposal. The amount of the check should be stated as a lump sum amount and not in terms of percentage of the bid, for in the latter case there is danger that the amount of the check secured for deposit with the bid may reveal the amount of the bid

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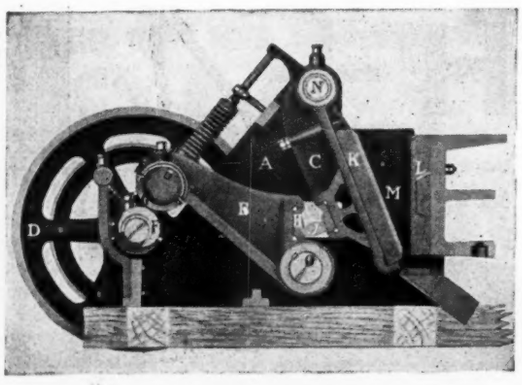

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to other contractors in advance of the opening of the bids. The amount of the certified check is generally about five per cent of the bid, although this may vary from one per cent to fifty per cent. The check may be held to cover loss sustained in case of failure to execute the contract, and this loss may be the difference between the bid accepted and the next higher bid or, in the case of re-letting, the difference between the former bid and the bid accepted in the re-letting, plus cost.

Specifications.—It goes without saying that the language of the specification should be as clear as it is possible to make it. To write an involved specification so that it cannot be misinterpreted is never easy and not always possible. Brevity and simplicity in the construction of sentences will, however, materially reduce the difficulties which may arise on the job.

Many specifications fail to give sufficient detail to enable a contractor to foresee, in making up his bid, exactly what is required. An instance of this came to the writer's attention some years ago. The specifications for a bridge job contained a clause which required the contractor, under his lump sum bid for the whole work, to provide an office for the engineer "suitably furnished, to the satisfaction of the engineer." Not knowing how particular the engineer might be about his office furniture, it was difficult for the contractor to estimate the requirements.

Generally, the specifications can be so written that it will be unnecessary to consult other sources of information to get the complete requirements. However, in work of considerable magnitude it is quite properly the practice in describing materials to refer to certain well established standards such as those which have been developed by the American Society for Testing Materials, American Water Works Association and others.

For economy of construction, stock materials and stock sizes should be specified. Also, a job may be delayed by having to make up a special pattern for a casting when a stock pattern would have suited the purpose.

When competitive bids are asked for, it is desirable that competition should be as wide and unrestricted as possible, consistent with the class of work to be done. There are various ways of calling for optional articles. The article desired may be called for by maker's name or trade mark "or equal." Again an article may be "equal to the sample on file" in the office of the architect or engineer. In public work it is not good policy to specify patented articles or articles manufactured by a single concern. The reason for this is obvious.

Specifications should provide sufficient latitude to enable contractors to exercise ingenuity in methods of work, but any special methods should be subject to approval by the architect or engineer before the work involving such special methods is started. This approval is necessary in order that the owner may keep proper control of the work, through his representative. In some cases, the results to be obtained may be specified and the contractor permitted to use his own methods, subject to approval, in obtaining these results. The specification should not detail both the method to be employed and the results to be obtained. Since the contractor is responsible for injury to persons and damage to property resulting from his work, he may be released from these obligations in case such injury or damage should occur when it can be shown that the contractor has used reasonable care in doing the work by the prescribed methods.

Engineering Societies

October 6-11—SIXTH INTERNATIONAL ROAD CONGRESS at Washington, D. C. Secretary General, Thomas H. MacDonald, Washington, D. C.

October 7-10—AMERICAN ROAD BUILDERS' ASSOCIATION. International Exposition of Highway Equipment and Material at Washington, D. C. Secretary-Director, Charles M. Upham, National Press Building, Washington, D. C.

October 9-11—INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Annual Conference at Louisville, Ky. A. M. Anderson, 100 No. La Salle Street, Chicago, Secretary.

October 13-17—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual meeting at Richmond, Va. Secretary, C. W. S. Sammelman, 315 Commercial Building, St. Louis, Mo.

October 27-31—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting at Fort Worth, Texas. Executive Secretary, Homer N. Calver, 370 Seventh Avenue, New York.

December 1-5—ASPHALT INSTITUTE. Ninth Annual Conference at Memphis, Tenn. Asphalt Institute, 250 East 43rd Street, New York.

Jan. 12-17—Road Show and ARBA Convention at St. Louis, Mo. C. M. Upham, National Press Bldg., Washington, D. C.

American Society for Municipal Improvements

The 36th annual convention of this society will be held at the Jefferson Hotel, Richmond, Va., Oct. 13-17.

At this year's convention the society will, for the first time confer the Greeley "Veteran's Award" on three of its members. This award is to be made annually to three members of the society who have continuously served a single municipality in an engineering capacity for at least twenty-five years. Those to be honored this year have so served for from 39 to 46 years. The program will begin Monday with registration and committee meetings. The formal opening of the convention will take place Monday evening. The technical sessions are as follows:

Tuesday, October 14, 9:30 A. M.—Traffic Control Committee Report. By E. A. Kemmler, Chairman, Highway Engineer, Akron, Ohio. Discussion. Unified Control of Transit Facilities, by C. A. Harrell, City Manager, Portsmouth, Ohio. Discussion. Street and Traffic Lighting Committee Report, by Frank D. Farrell, Chairman, Buffalo, N. Y. Street Lighting and Traffic Accidents, by Kirk M. Reid, Illuminating Engineer, National Lamp Works, Nela Park, Cleveland, Ohio. Discussion. Modern Trends in Street Lighting, by F. C. Eteson, Illuminating Engineer, Virginia Representative of the Illuminating Engineering Society, Richmond, Va. Discussion. Solving Problem of Improving Curb Line Appearance, by W. B. Vick, Sales Engineer, Union Metal Manufacturing Co., Canton, Ohio.

Tuesday Afternoon, starting at 2:30 P. M., there will be a sight-seeing trip around Richmond, including historic St. Johns Church where Patrick Henry made his famous speech of liberty, Battle Abbey of the Confederacy, and the famous "Maymont" Park.

Tuesday, 8:00 P. M.—Airports and Landing Fields Committee Report, by Perry A. Fellows, Chairman, Detroit, Mich. Control of Traffic at Airports, by W. J. Wallace, Engineer-Manager of the Detroit City Airport, Detroit, Mich. American Airports as Seen by an Engineer, by F. E. Schnepfe, Manager, Highway Engineering Bureau, Washington, D. C. Street Paving, Design, Construction and Maintenance Committee Report, by John W. Reid, Chairman, Consulting Engineer, Detroit, Mich. Factors in the Design and Construction of Concrete Street Pavements, by H. C. Whitehurst, Highway Engineer, District of Columbia, and H. F. Clemmer, Engineer of Materials, District of Columbia. Vitrified Brick Pavement Construction, by A. Mason Harris, Chief of Bureau of Streets, Department of Public Works, Richmond, Va. Interaco Amiesite, by George H. Bunker, Chief Engineer, Interstate Amiesite Co., Martinsburg, W. Va. Survey Methods and Results at Richmond, Virginia, by George J. Parrish, Division Engineer of Surveys, Department of Public Works, Richmond, Va.

Wednesday, October 15, 9:30 A. M.—Water Works Committee Report. By L. R. Howson, Chairman, Chicago, Ill. Problems of Richmond's Water Purification Plant, by Marsden C. Smith, Water and Electrical Engineer, Department of Public Utilities, Richmond, Va. Municipal Water Softening, by Charles P. Hoover, Chemist in Charge, Water Softening and Purification Works, City of Columbus, Ohio. The Nashville Tennessee Filtration Plant, by J. F. Laboon, Consulting Engineer, Pittsburgh, Pa. Micromovies, by Major John B. Hawley, Consulting Engineer, Fort Worth, Texas. Specification Committees Reports: Brick Pavements, by George F. Fisk, Chairman; Subgrades and Foundations, by William Aldridge, Chairman; Stone Block Pavements, by C. D. Pollock, Chairman; Municipal Contract Forms, by W. W. Horner, Chairman; Cement Concrete Pavements, by Hy. L. Howe, Chairman; Sewers, by Asa E. Phillips, Chairman; Sidewalks and Curbs, by S. Cameron Corson, Chairman; Bituminous Pavements, by Julius Adler, Chairman; Street Railway Pavements and Track Construction, by C. L. Hawkins, Chairman; Reports by Representatives in Other Organizations. Nominating Committee Report and Election of Officers will be heard at 12:15.

Wednesday, 1:30 P. M.—City Planning Committee Report, by Jacob L. Crane, Jr., Chairman, Town Planner and Landscape Architect, Chicago, Ill. Facilitating Traffic Flow at Street and Highway Intersections, by E. P. Goodrich, Consulting Engineer, New York, N. Y. The Economic Value of Laying Out Roadways for Steady-flow Traffic, by Fritz Malcher, Traffic Consultant, New York, N. Y. Parkways and Super-Highways, Their Comparative Advantages in Interurban Planning by J. Downer, Chief Engineer, Westchester County Park Commission, Bronxville, N. Y. Does Zoning Retard Building Operations? by Francis J. Mulvihill, Chief of the Division of City Planning and Municipal Engineering, Commonwealth of Pennsylvania, Harrisburg, Pa. Municipal Legislation and Finance Committee Report, by W. C. Bernard, Chairman, Municipal and Valuation Engineer, St. Louis, Mo. Legal Phases of Street Development, by Alfred Bettman, Member City Planning Commission, Cincinnati, Ohio. The Allocation of the Cost of Storm Water Sewers Between Municipalities, by Edward S. Rankin, Division Engineer, Division of Sewers, Newark, N. J. Financing Street Paving in Small Cities, by Harry Tucker, Professor of Highway Engineering, North Carolina College, Raleigh, N. C. Modern Trends in Condemnations Procedure, by W. C. Bernard, Municipal and Valuation Engineer, St. Louis, Mo.

On Wednesday evening at 8:00 P. M. the annual A. S. M. I. Banquet will be held.

Thursday, October 16, 9:30 A. M.—Sewerage and Sanitation Committee Report, by A. P. Learned, Chairman, Consulting Engineer, Kansas City, Mo. Dilution Requirements for Sewage Treatment Plant Effluents, by Almon L. Fales; Metcalf and Eddy, Boston, Mass. Chlorination of Sewage and Sewage Effluents, by George B. Gascoigne, Consulting Sanitary Engineer, Cleveland, Ohio. Reliability and Economy of Separate Digestion Vindicated by Study of Five Years Operating Results, by E. B. Besselievre, Manager, Eastern Territory, Sanitary Engineering Division, The Dorr Company, New York, N. Y. The Activated Sludge Process, New Developments in Mechanical Aeration, by John L. Mason, Sewage Research Engineer, Hardinge Company, York, Pa. Further Studies in Activated Sludge, by Michael J. Blew, Research Engineer, Department of Public Works, Philadelphia, Pa. The Shockoe Creek Drainage Project, by G. C. Molleson, Department of Public Works, Richmond, Va.

Thursday, 1:30 P. M.—Refuse Disposal and Street Cleaning Committee Report, by E. E. Butterfield, Consulting Chemist, 70-04 Dartmouth Street, Forest Hills, N. Y. The Combustion of Organic Wastes, by E. E. Butterfield, Consulting Chemist, 70-04 Dartmouth Street, Forest Hills, N. Y. Cleaning a City's Streets, by Lester W. Herzog, President Common Council, Albany, New York. Standard Units and Costs as Aids to Sanitation Management, by Donald C. Stone, Director Committee on Uniform Street Sanitation Records of the International Association of Street Sanitation Officials, Chicago, Ill. Public Utilities Committee Report, by Gerald J. Wagner, Chairman, President, G. J. Wagner and Co., Consulting Engineers, Grand Rapids, Mich., and Chicago, Ill. Street Traffic and Public Transit Facilities, by H. S. Simpson, Research Engineer, American Electric Railway Association, New York City, N. Y. Public Utility Rates, by Frank A. Newton, Rate Engineer, Commonwealth and Southern Corporation, New York City, N. Y.

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American Road Builders' Association

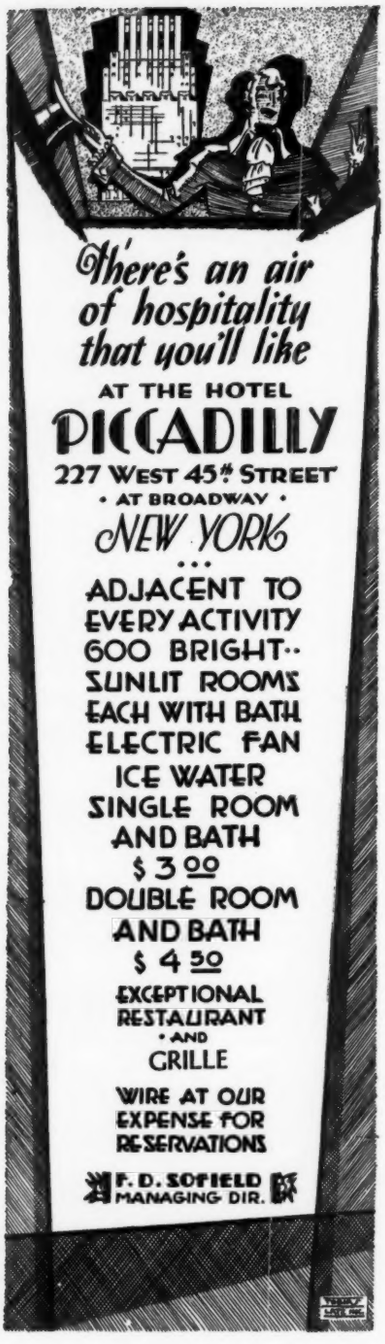
Outdoor demonstration of road building equipment and materials will constitute a valuable part of the program arranged for the Sixth International Road Congress to be held at Washington, D. C., October 6-11.

The opening of the exposition will take place October 7, following the opening sessions of the road congress the previous day. A luncheon will be tendered to all delegates by the American Road Builders' Association and the afternoon and evening will be set aside for attendance at the exposition and the outdoor demonstrations which will be carried on a short distance from the auditorium and the United States Chamber of Commerce building, where congress registration and business sessions will take place.

Special honors will be paid by the American Road Builders' Association to its honorary Pan American and European representatives, many of whom will attend the road congress as official representatives of their governments.

Notable among this group will be Ing. M. A. Coroalles, chief engineer of roads and bridges, Havana, Cuba, who is president of the Association's Pan American Division, comprised of honorary members from all the Central and South American countries. He will be accompanied by Ing. Don Miguel Villa, Adolfo Arellano, Pablo Ortega and Francisco J. de Sola, honorary members from Cuba.

Among the official delegates from Mexico will be Alfredo Becerril Colin, federal highway commissioner; Leopoldo Farias, chief of the construction department; and Andres Ortiz, governor-elect of the state of Chihuahua. This group will arrive several days prior to the congress opening and will be guests of the Association on inspection tours of highways in the vicinity of Washington.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All available space in the Washington auditorium has been taken by highway equipment manufacturers and additional requests for space are daily being received. A large space will be used by the United States Bureau of Public Roads to demonstrate its work in the new science of subgrade soils, a subject which will be of keen interest to the majority of the foreign delegates.

President W. A. Van Duzer has announced the appointment of M. de Glopper, materials and equipment engineer, highway department, Lansing, Mich., as chairman of the equipment committee.

This committee, which has done work of immense value to the road building industry in previous years, will take up in this year's program: snow removal equipment; standardization of purchasing methods; operation and development of traffic control signals, streets and highways; power requirements for operation of various types of road machinery; survey of need for and availability of maintenance equipment; central and transit-mix concrete equipment.

The chairman will be assisted by subchairmen in charge of the various investigations and the entire committee membership of highway industry leaders. The report will be prepared with the assistance of a headquarters staff investigator and will be presented at the annual convention and road show in St. Louis in January, 1931.

Southwest Road Show and School

The Sixth Annual Southwest Road Show and School will be held at Wichita, Kans., February 24 to 27, 1931. The Good Roads School Program will be arranged under the supervision of the Kansas State Highway Commission and the Kansas State Agricultural College in cooperation with the Highway Commissions of the Southwest states, United States Bureau of Public Roads, Colleges and Universities.

United States Good Roads Assn.

Charlotte, N. C., will entertain the nineteenth annual convention of the United States Good Roads Association, United States Good Roads Show and sixteenth annual convention of the Bankhead National Highway Association, May 4-8, 1931.

After the convention has closed its meeting, it is planned to go in a body by train or automobile to Washington, call on President Hoover and Congress and urge the passage of an appropriation to build a system of hard-surfaced highways.

New York State Sewage Works Association

The fall meeting of the New York State Sewage Works Association was held at the Onondaga Hotel, Syracuse, N. Y., September 13, 1930. Eighty members and guests attended. C. A. Holmquist, president, presided and paid tribute to the memory of Kenneth Allen, founder and first president of the Association. The announcement of the passing of Mr. Allen was a distinct shock to all present and a fitting resolution was adopted.

Following a brief business meeting, two papers were presented, one on "Chlorine Uses at Sewage Plants" by L. H. Enslow of the Chlorine Institute and the other on "Stream Pollution from the Operator's Standpoint" by Professor E. B. Phelps of Columbia University. The discussion of the papers was respectively opened by C. R. Cox and A. F. Dappert, both of the State Department of Health.

At the luncheon, Dr. George Ruhland, Health Commissioner of Syracuse, welcomed the members and spoke on "The Relation of the Sanitary Engineer and the Health Officer in Community Health Protection."

In the afternoon an inspection trip was made to the main sewage treatment works of the city of Syracuse, the Solvay lime wastes beds where the sludge is disposed of and to a small plant at Eastwood where separate sludge digestion and control were demonstrated.

After a dinner in the evening, a lively round table discussion with Vice President Morris Cohn presiding was held. R. S. Rankin, John F. Skinner and Harry W. Eustance led the discussion on the following topics, "Metal Preservation Above and Below Sewage Surface," "Garage Wastes" and "Experience with Small Pumping Stations." A paper prepared by Dr. J. F. T. Berliner on "The Ammonia-Chlorine Treatment of Sewage" was read by Mr. West.

The next meeting of the Association will be the Third Annual meeting and will be held in Albany at the time of the winter meeting of the New York State Conference of Mayors.

Michigan Road Show

The Michigan Road Show, under the auspices of the Michigan Association of Road Commissioners and Engineers and the Michigan State College, will be held at East Lansing in the Demonstration Building on the college campus, October 28th, 29th and 30th.

Personals

C. M. Osborn has been appointed City Manager of the village of Wilmette, Ill. He formerly served as city manager for Kenosha and Sherwood, Wis.

Samuel J. Hunt, formerly sales manager for Wiard Plow Co., has assumed the duties of Vice-President and general manager of sales of the Contractors Machinery Corporation, Batavia, N. Y. The new company will manufacture and sell "Trojan" tractor equipment and contractors tools.

Kenneth Allen, since 1916 sanitary engineer of the New York City Department of Sanitation, died at his home, at White Plains, N. Y., Sept. 7. He was seventy-three years old. Mr. Allen had long been in poor health and his retirement was to have taken effect soon for that reason.

A native of New Bedford, Mass., Mr. Allen was graduated from Rensselaer Polytechnic Institute in 1879. He did some railroad work in the West and then, from 1883 to 1886, he was connected with the Philadelphia Water Department. Next he went to Kansas City to engage until 1890 in private practice, to which he returned intermittently between appointments to various technical positions in Eastern cities. From 1908 to 1914 he was engineer for the Metropolitan Sewerage Commission of New York and in the following two years he was engineer for the Bureau of Sewer Plan. He was a charter member of the Tramp and Trail Club of New York and of the Westchester Trails Association.

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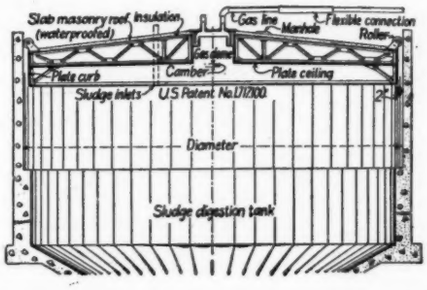

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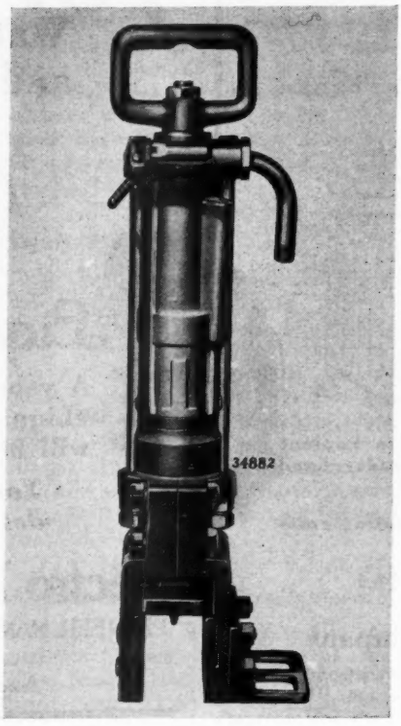
Engineering and Construction Equipment

New Machinery, Apparatus, Materials and Methods and Recent Installations.

New I-R Pile Driver for 3-Inch Sheeting

A new and larger air-operated pile driver that will drive 3-inch sheet piling is announced by Ingersoll-Rand Co. This tool, the R-30, weighs 148 pounds. It can be readily carried by 2 men and can be operated by one after it has been placed in position. By adding removable cheek plates, it can be used to drive 2½ and 2-inch piling as well as 3-inch.

The R-30 eliminates most of the splitting of piles, permitting the same pieces to be used several times. It is low in air consumption: A 7 x 6-inch portable compressor will operate 2 tools. There are no exterior moving parts, which makes it safe to use. The R-30 will do much of the work that has formerly required steam hammers weighing as much as 400 pounds. It is equipped with a removable footpiece that allows the operator to add his weight to that of the tool when such is desirable.



Ingersoll-Rand Pile Driver for 3-inch Sheeting.

Barber-Greene Company Builds a New Small Ditcher

A vertical boom ditcher that is only 4 feet wide and 11½ feet long, and will dig a trench from 5 to 8 inches wide, and from 1 up to 3 feet deep at varying speeds from 15 inches to 12 feet a minute is the latest achievement of the Barber-Greene Company of Aurora, Illinois.

The new machine—the Service Special Ditcher—has all of the features of the big Barber-Greenes. It is crawler mounted. It has the vertical boom which allows it to dig right up to a sidewalk or curb, ending the trench flush, and to cut a square corner. As an insurance against strains caused by striking underground obstacles and as a protection to any underground pipes, the machine is equipped with the standard B-G Overload Release Sprocket, a device that automatically stops the bucket line without injuring anything or killing the engine.

The buckets clean themselves automatically, even in very sticky material. Attached to the boom is a telescoping follow-up scraper which insures a clean trench. The boom is raised by power, making it possible for the operator to dig accurately to grade at all times.

The traveling speeds of the Service Special are two miles and one and one-third miles per hour.

Although perhaps the lightest ditcher made, it is built throughout of heavy structural steel and is powered by a 33 B.HP. four cylinder Buda gasoline engine.

Chlorine in Its Newest Form

The Mathieson Alkali Works, Inc., New York, has developed high-test-hypo, known as HTH. This is stated to be a true hypochlorite, with 65 per cent available chlorine, in a stable, dry, free-flowing powder, uniform in composition, and readily soluble. It is claimed there is no loss of strength when it is stored for prolonged periods, either in winter or in summer. It requires no special storage conditions.

HTH is packed in 4-pound cans, each containing exactly 2½ pounds of available chlorine. It can also be secured in 110-pound drums.

New Compound Effectively Seals Joints

The Quigley Company, Inc., 56 West 45th Street, New York City, manufacturers of Hytempite and Triple-A Protective Coatings, announce the manufacture of a plastic, expansive compound for sealing joints, called Q-Seal.

Q-Seal is easily applied to joints to be sealed with a brush. The expansive qualities fill any imperfections in threads, flanges or gaskets. The compound seals joints leak-proof, prevents rust and corrosion. Joints fabricated with it may be broken with ease regardless of age or conditions they have been subjected to. The compound is very economical to use.

Barber-Greene New Small Ditcher.

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All of the exclusive Galion Grader features found in the larger machines are embodied in this new 70. A few of them are: double gear segments and pinions for leaning wheels; Galion patented E-Z Lift Springs; Galion patented Automatic Skew Axles; renewable ball and socket joints on lift controls; cone and socket tightening device connecting moldboard to circle; and special tapered universal joint on steering rod to prevent locking while steering.

In addition to these features this husky little grader is fitted with accurately machine-cut worms and gears enclosed in oil tight, dust proof cases and running at all times in a bath of oil; Alemite lubrication; and Timken tapered roller bearings in the wheels.

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Table of Contents.....17; New Appliances.....81; Industrial Literature 93;
Directory of Consulting Engineers.....89-90; Advertising Index.....100

Sanitary Engineers and City Officials:—

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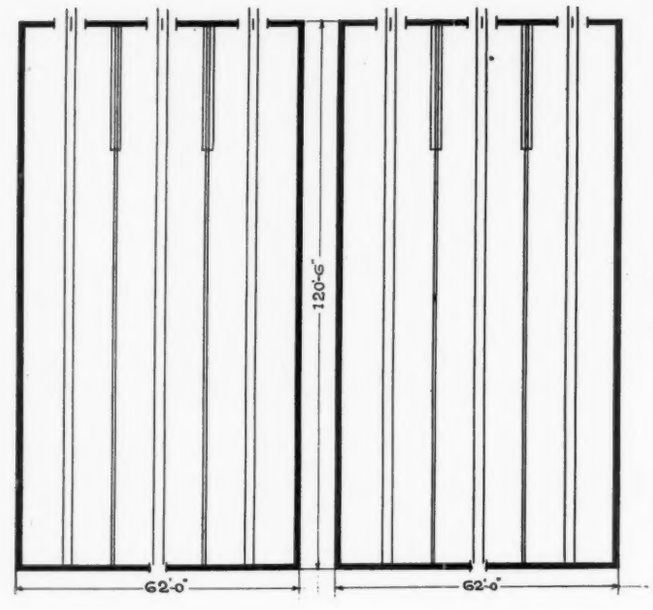
These two glass covers will be constructed during November. They will embody all the outstanding Super-Frame features that assure greater efficiency and endurance.



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With Our Authors

CARLTON N. CONNER is a graduate in Civil Engineering from Tufts College, Massachusetts. After ten years of design and construction on railroads, water supply, irrigation, bridges, highways, buildings, and river improvements in several states and the Philippine Islands, he entered highway work in its second and most active decade.

Mr. Conner was Construction Engineer for the State of Delaware during its most active highway program, State Construction Engineer in North Carolina during the construction of its one hundred million dollar program, Chief Engineer for the Mexican Highway Commission during its early construction and standardization period, reported on Low Cost Improved Roads for the Highway Research Board, and is now Engineer Executive for the American Road Builders' Association.

Mr. Conner is a member of the principal engineering societies and associations interested in highway activities, and a member of the Design Committee, Highway Research Board. He has long been a valued contributor to PUBLIC WORKS.

J. P. COCKEY, *Assistant Engineer, American Road Builders' Association,* graduated from Johns Hopkins University in engineering and started work in Anne Arundel County, Maryland, as assistant on road, bridge and sewerage construction. He joined the Army in November, 1917, and served with the 23rd Engineers. Spent fifteen months in France on actual railroad, railroad bridge, highway and highway bridge construction.

For nearly one year, was in charge of survey party on highway location for South Carolina Highway Department. Worked at the Bureau of Standards for nearly two years in the cement and concrete sections. Assisted in testing of concrete and feasibility of concrete tanks as storage of gasoline and crude oil. Was employed by the North Carolina Highway Commission in the testing and construction departments as assistant engineer for six years. After leaving the North Carolina Highway Commission, was two years with the Roberts Paving Company on concrete highway construction; was placed in charge of field office work on different locations, made many plant set-ups, and was on special duties involving any difficulties experienced in handling or use of materials.

He joined the engineering staff of the American Road Builders' Association in November, 1929.

JAMES LAWRENCE THAYER was born in 1882 in Minnesota, but came to Washington at the age of 6. Graduated from Spokane high school '02 and from the Washington State College '07, B. A. degree. Taught in high school Davenport, Washington, and

In DETROIT . . .
91 year old *cast iron mains* are still young and strong

Photo by Fairchild Aerial Surveys, Inc.

THE long life of cast iron pipe is attested by the official records of America's leading cities. For instance, Mr. F. H. Stephenson, Engineer of the Detroit Water Commissioners writes: "In 1853 the Secretary of the Detroit water system published a history of the Detroit water works . . . From a study of this history I find that in 1839 a 10-inch cast iron main was laid in Jefferson Avenue from Randolph Street to Woodward Avenue. *This main is still in service.*"

91 years under ground and still going strong! Certainly a splendid performance. But, it isn't a record for cast iron pipe. Philadelphia can point to cast iron mains still in service after 100 years. So can Richmond. So can St. Louis. In fact the full life span of cast iron pipe has yet to be measured.

The reason for the durability of cast iron pipe is its effective resistance to rust and corrosion. Water and gas mains of ferrous metal (iron and steel) with the exception of cast iron, disintegrate from rust. Cast iron pipe is the only ferrous metal pipe practicable for underground mains which rust will not destroy.

For complete information regarding the economy of specifying cast iron pipe for water, gas, sewers, culverts or industrial needs, write to Thomas F. Wolfe, Research Engineer, 309 Peoples Gas Building, Chicago, Illinois.

Cast iron pipe bearing the "Q-check" trade mark is obtainable from the following leading pipe founders: Alabama Pipe Company, Anniston, Ala.; American Cast Iron Pipe Company, Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Avenue, Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Company, Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Pipe and Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York.

Look for the "Q-check" symbol stenciled in white as shown above. It is the registered trade mark of the Cast Iron Pipe Research Association

CAST IRON PIPE

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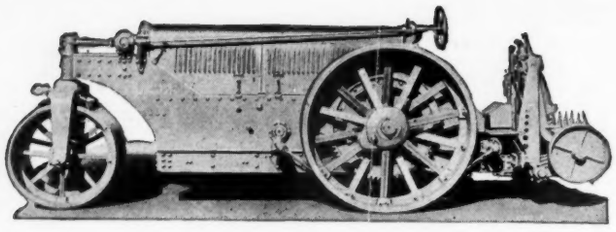

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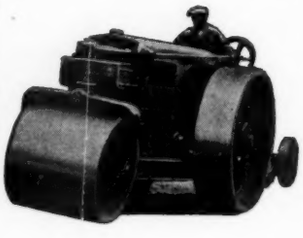

Built in every practical weight and size, both steam and motor driven, three wheel and tandem. Scarifier and other attachments optional.

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for a time was Superintendent of Schools (Davenport City). In 1910 was elected to the office of county engineer and for 8 years served as county engineer and deputy county engineer; for the past 12 years he has served as construction engineer of Lincoln County, an appointive office, the office by election having been abolished. Then he has served in the county highway department 20 consecutive years, 16 years as its head. During this time the highway system has grown from nothing to 565 miles of improved roads.

He wrote a thesis, "The Development of a County Highway System in a Sparsely Populated Semi-Arid Region." This thesis was accepted by the Washington State College and the C. E. degree conferred.

"Am not a writer but have written a few articles for road magazines, one of which, 'Road Corrugations,' appeared in The Literary Digest. Have been a director of the Lincoln County State Bank of Davenport for 12 years and president for the past 5 years. Own and operate a wheat ranch."

I. W. Mendelsohn is an associate sanitary engineer of the United States Public Health Service. He begins, in this issue of PUBLIC WORKS, a series of comments on public health engineering activities. Mr. Mendelsohn is known to all sanitary engineers as the man who started *"Public Health Engineering Abstracts"* which are sent out weekly by the Public Health Service, a service greatly appreciated by hundreds of engineers engaged in sanitary engineering. A more extended sketch of Mr. Mendelsohn's activities will appear in an early issue of PUBLIC WORKS.

Leon Luke, who contributed the article on "Low Cost Asphaltic Gravel Roads," is county engineer of Macomb County, Michigan. Faced with the problems that confront so many county engineers of providing good roads with limited funds, Mr. Luke has found a solution that should be of considerable value to others. He has used local materials in bituminous construction so effectively that a smooth-riding, dustless road has been provided at about the annual costs of maintaining a gravel surface.

J. Paul Ambler, in his article describing the use of bulk cement on concrete road construction, points the way to a very impressive saving in construction costs. Mr. Ambler is assistant construction engineer of the Pennsylvania Department of Highways. We hope to have a picture of Mr. Ambler in an early issue, and also more data concerning him.

Denzil Doggett is assistant state engineer, Indiana Department of Conservation. *P. B. Streander* is associate engineer, Remington, Vosbury & Goff, consulting engineers, Camden, N. J. He continues the series of articles describing plants illustrating latest developments in sewage treatment. This plant is located in the center of a built-up community.

Book Reviews

Byrne's Inspector's Pocket Book. By Austin T. Byrne. Revised by Samuel T. Goldsmith. 244 pages 5 x 8 inches. Paper cover, stiff binding. Gillette Publishing Co., Chicago, Ill., distributor. $3.

First prepared by Mr. Byrne in 1898, this book has been brought up to date by Mr. Goldsmith. The book is not printed, but is lithographed (or similarly) from typing. It covers a wide range of subjects, presenting the duties of the inspector, the characteristics of the materials, and the points to which special attention

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Pulling up sand, muck, stones and water with the help of the dependable—

They used a 6-inch Humdinger on the Passaic River job. Five other sizes 100 to 150 GPM.

HUMDINGER

SELF-PRIMING CENTRIFUGAL PUMP

A big New Jersey contractor was working on the construction of a sewer station, next to and below the level of the Passaic River. It was a ticklish job. Down there were tons of sand and stones and muck, besides the water—the kind of job that any ordinary pump goes dead on, after the first few snorts. But the Humdinger (a six-inch) went right after it—had it licked in a short time.

Humdinger has a 3-vane chrome alloy impeller, stainless steel shaft—but no priming pumps, no complicated parts. Large air capacity. We gladly supply information on all models.

That's the point about the Humdinger self-priming centrifugal—takes water as it comes to the hose, and handles large quantities of mud and sand besides. Never gets out of order. Costs less.

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should be directed on earthwork; foundations; timber; masonry; concrete; brick; arch, wall and pier construction; waterproofing; ducts and conduits; plastering; carpentry; roofing; plumbing; glass; painting; water supply, including steel and cast iron pipes, coatings, testing and laying pipes, joints, etc.; sewerage, including joints, pipes, shoring, pumping, foundations and backfilling; and all common varieties of pavements, and also grading, drainage and curbing. At the end is a list of definitions of terms used in construction, and a form of inspector's monthly report.

Appraisers and Assessors Manual. By W. L. Prouty, Clem W. Collins and Frank H. Prouty. 500 pages. Illustrated. McGraw-Hill Book Co., Inc., N. Y. $5.

This is a most carefully and thoroughly prepared presentation of material covering appraising and assessing. We agree with the publishers' statement: "The book covers every phase of the work in detail, gives scientific principles for the valuation of property, especially for taxation purposes; systems and methods drawn from actual practice all over the country are illustrated by useful and authoritative data and many new and original rules, tables, charts and illustrations. To all who are concerned in any way with the appraisal of land, buildings, machinery, merchandise, personal property, automobiles and other property, this book gives reliable, clear and complete information."

Itemized Construction Costs on Water and Sewage

(Topeka, Kans.)

Water Works Extension

Date of Contract—June, 1930

	Total
24 lin. ft. 6-in. cast iron pipe, using leadite; cost per ft. $1.50; total	$ 36.00
11,231 lin. ft. 18-in. cast iron pipe, using leadite; cost per ft. $5.32; total	59,748.92
4 4-ft. brick manholes for water valves; cost each $50.00; total	200.00
34,050 lbs. special castings; cost per lb., .09; total	3,064.50
17 Hub end 18-in. gate valves, without bypass; cost each $220; total	3,740.00
3 Hub end 18-in. gate valves, with bypass; cost each $280; total	840.00
7 Hub end 6-in. gate valves, without bypass; cost each $50; total	350.00
2 Hub end 4-in. gate valves, without bypass; cost each $25; total	50.00
1 fire hydrant; cost each $85; total	85.00

Total contract price: $68,114.42.

Contractor—Kirkham and Kilmer.

Sewer Construction

Date of Contract—July 22, 1930

	Total
3,738 lin. ft. 0'x10' trenching and backfilling; cost per lin. ft. .50	$1,869.00
1,152 lin. ft. 10'x14' trenching and backfilling; cost per lin. ft. .73	840.96
10 cu. yds. rock excavation in trench; cost per cu. yd. $5	50.00
5 std. flushing manholes, complete; cost each $82.50	412.50
11 std. shallow manholes, complete; cost each $66	726.00
52 vert. ft. extra depth manholes; cost per vert. ft. $5.50	286.00
525 lin. ft. 2-in. cast iron water line; cost per lin. ft. .93	488.25
4,376 lin. ft. 8-in. V.C.P. fur. and laid; cost per lin. ft. .47	2,056.72
514 lin. ft. 10-in. V.C.P. fur. and laid; cost per lin. ft. .57	292.98

Total contract price: $7,022.41.

Contractor—C. A. Ritchie.

Information furnished by—F. W. Knapp, city clerk.

(Kansas Municipalities)

Two Pipes of Peace!

TO have peace in his mind, a water works man's got to have cast iron pipe in his mains! Then the old cob pipe hits on all six when his day's work is done. He knows rust and rot cannot harm his distribution system this year, next year, or next century. Cast iron **lasts.**

And the wiser ones have extended a good idea downward into the 1¼ and 2 inch sizes too—adopted McWANE cast iron pipe for the small outlying lines, for the newly-popular two-main systems in residential blocks, and for services everywhere.

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with the new McWane booklet. Learn of new advantages, new uses for cast iron pipe. McWane is making 2-inch, for example, in 18-foot laying lengths now. Get your copy of new Small Pipe booklet now. "At least **find out.**"

Sizes: 1¼ to 12 Inches

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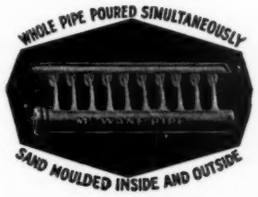

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McWANE CAST IRON PIPE

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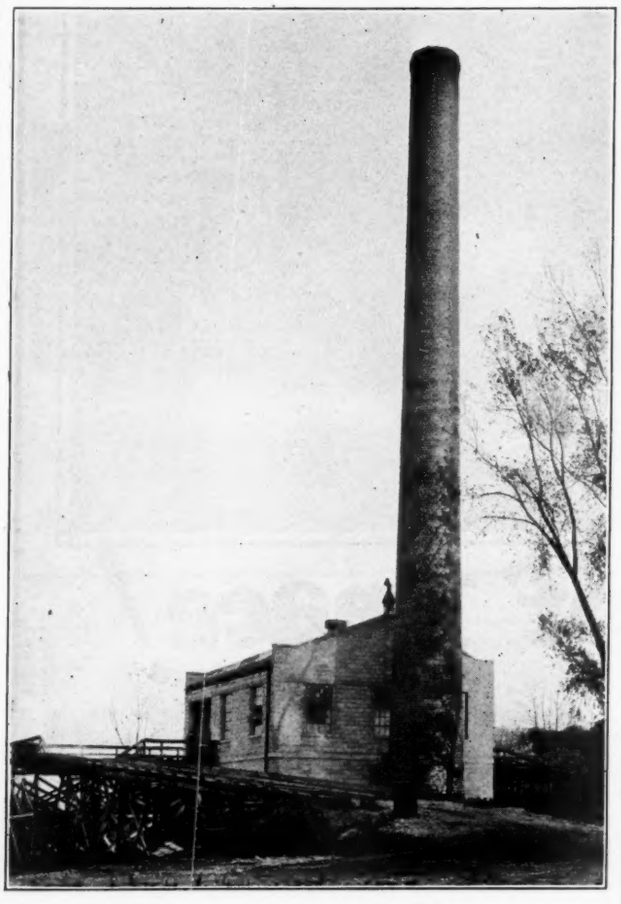
PDM Incinerators Permit Selective Charging, Are "Foolproof" and Simple to Operate



This modern PDM destructor erected for the City of Wauwatosa, Wisconsin has a daily capacity of 80 tons of refuse and garbage.

The operation of a municipal incinerator plant (after the official tests and acceptance are completed) is usually in the hands of unskilled labor. Incinerators should, therefore, be simple to operate and "foolproof." The PDM plant is designed and erected in recognition of these practical operating facts.

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Itemized Costs on Macadam and Gravel Roads

8-Inch Waterbound Macadam Construction

Town of Danbury, Conn. Length, 22,846 ft. Width, 18 ft. Bids received 8-25-30.

Items	Unit	Quant.	(1) Unit Price	(2) Unit Price	(3) Unit Price
No. Working Days	$40.00		40dy	50dy	40dy
Cleaning and Grubbing	ls	....	....	....	....
Earth Excav.	cy	22,000	.65	.45	.50
Rock Excav.	cy	7,200	.65	2.00	2.00
Wet Excav.	cy	500	.65	2.25	3.00
Culvert & Ditch Excav.	cy	500	.65	.90	.50
Borrow	cy	1,433	.75	1.15	.50
Form. Subgrade	sy	45,692	.03	.05	.02
CleanSlopes&Shoulders	lf	22,846	.03	.05	.03
Gravel Fill Subbase	cy	12,000	.90	1.25	.75
Broken Stone	Tons	23,000	2.20	2.00	2.50
Special Cl. A. Conc.	cy	10	25.00	32.00	23.00
Class B. Concrete	cy	240	17.00	17.00	15.00
Install 18" R.C. Pipe	lf	1,188	1.00	1.00	.80
Install 24" R.C. Pipe	lf	244	1.00	1.50	1.75
Install 30" R.C. Pipe	lf	88	1.50	3.00	2.75
Install 48" R.C. Pipe	lf	88	3.00	4.00	5.50
Vit. Tile Underdrain	lf	1,700	2.25	1.25	1.00
Vit. Tile Outlets	lf	100	.75	1.00	.50
Plain Cobble Gutter	sy	150	1.00	2.00	.80
Stone Wall, Fence	lf	450	1.00	.75	.80
Wire Fence	lf	15,500	.17	.18	.15
Wire Rope Railing	lf	3,700	.50	.48	.50
Railing Posts	each	270	1.00	.80	.40

(1) Osborn-Barnes; (2) Sullivan & Godfrey, Bridgeport; (3) J. De Michiel Bros., Torrington.

7-Inch Waterbound Macadam Construction

Town of Orange, Conn. Length, 17,465 ft. Width, 18 ft. Bids received 8-25-30.

Items	Unit	Quant.	(1) Unit Price	(2) Unit Price	(3) Unit Price
No. Working Days	$40.00		40dy	35dy	60dy
Clearing & Grubbing	ls	....	....	....	....
Earth Excav.	cy	25,615	.40	.60	.48
Earth Ex. for Ditches	cy	43	1.25	2.00	1.00
Rock Excav.	cy	4,922	1.50	.60	1.00
Wet Excav.	cy	237	2.00	2.25	1.50
Form. Subgrade	sy	36,678	.01	.05	.03
Cl. Slopes & Shoulders	lf	17,466	.05	.05	.03
Gravel Fill Subbase	cy	3,168	.65	.80	.45
Broken Stone	Tons	16,688	1.75	1.75	1.95
Class A. Concrete	cy	51	20.00	17.00	18.00
Class B. Concrete	cy	224	13.00	12.50	16.00
Deformed Steel Bars	Lbs.	5,202	.04	.05	.05
Catch Basins	ea.	3	60.00	50.00	45.00
Install. 15" R.C. Pipe	lf	716	.75	.80	.70
Concrete Bridge Rail	lf	51	7.00	7.50	6.00
Stone Wall Fence	lf	1,000	.20	.75	.20
Wire Fence	lf	1,000	.20	.20	.20
Wire Rope Railing	lf	2,850	.55	.52	.45

(1) New Haven Rd. Constr. Co., New Haven; (2) Clark-Barone, New Haven; (3) Edgewood Constr. Co.

6-Inch Gravel Road Construction

Town of Scotland, Conn. Length, 10,078 ft. Width, 20 ft. Bids received 8-25-30.

Items	Unit	Quant.	(1) Unit Price	(2) Unit Price	(3) Unit Price
No. Working Days	$25.00		60dy	35dy	45dy
Clearing & Grubbing	ls	....	....	....	....
Earth Excav.	cy	12,915	.40	.40	.50
Rock Excav.	cy	575	3.00	.40	2.00
Wet Excav	cy	25	2.00	2.00	.50
Cl. Slopes & Shoulders	lf	10,078	.05	.01	.05
Borrow	cy	7,000	.40	.40	.40
Gravel Fill Subbase	cy	4,000	.45	.50	.70
6" Gravel Surface	sy	22,900	.17	.20	.17
Special Cl. A. Conc.	cy	16	20.00	35.00	20.00
Cement Rubble Masonry	cy	70	10.00	9.00	10.00
Catch Basins	ea.	2	60.00	60.00	100.00
In. 15" Bit. CCM. Pipe	lf	342	.50	.40	.50
In. 18" Bit. CCM. Pipe	lf	156	1.00	.50	.50
In. 24" Bit. CCM. Pipe	lf	68	1.00	.75	2.00
In. 36" Bit. CCM. Pipe	lf	36	2.00	1.00	4.00
Vit. Tile Underdrain	lf	100	1.50	1.50	1.50
Vit. Tile Outlets	lf	25	.60	1.00	1.00
Stone Wall Fence	lf	8,000	.55	.70	.50
Wire Fence	lf	1,700	.22	.19	.23
Wire Rope Railing	lf	5,100	.47	.50	.50
Single Cable Posts	each	60	1.00	1.00	1.00

(1) H. T. Smith Express Co.; (2) Arborio Rd. Const. Co., Hartford; (3) Hagan-Thibodeaux Co., Providence, R. I.